SOIL SURVEY OF

Goldstream-Nenana Area, Alaska

United States Department of Agriculture
Soil Conservation Service
in cooperation with
University of Alaska
Institute of Agricultural Sciences

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1958-72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the area in 1973. This survey was made cooperatively by the Soil Conservation Service and the University of Alaska, Institute of Agricultural Sciences. It is part of the technical assistance furnished to the Alaska Soil Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of the Goldstream-Nenana Area are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the management group (capability classification) of each. It shows the page where each soil is described and the page for the management group and woodland suitability group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the management groups, and the woodland suitability groups.

Foresters and others can refer to the section "Use of the Soils as Woodland," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Community planners and others can read about soil properties that affect the choice of sites for dwellings and industrial buildings in the section "Engineering Uses of the Soils."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in the Goldstream-Nenana Area may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the Area in the section "General Nature of the Area."

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Summary of Tables

SOIL SURVEY OF GOLDSTREAM-NENANA AREA, ALASKA

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THE GOLDSTREAM-NENANA AREA is partly in the Tanana Valley of interior Alaska and partly in the Yukon-Tanana Upland north of the valley (fig. 1). The Area includes about 510 square miles in a strip 2 to 15 miles wide and 68 miles long. It extends from Ester Dome southwestward between the north bank of the Tanana River and a high ridge north of the Goldstream Valley to Nenana, and south from Nenana to the south boundary of T. 8 S. Although Clear Air Force Base is located in the Area, it was not mapped.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the Goldstream-Nenana Area, where they are located, and how they can be used. The soil scientists went into the survey area knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

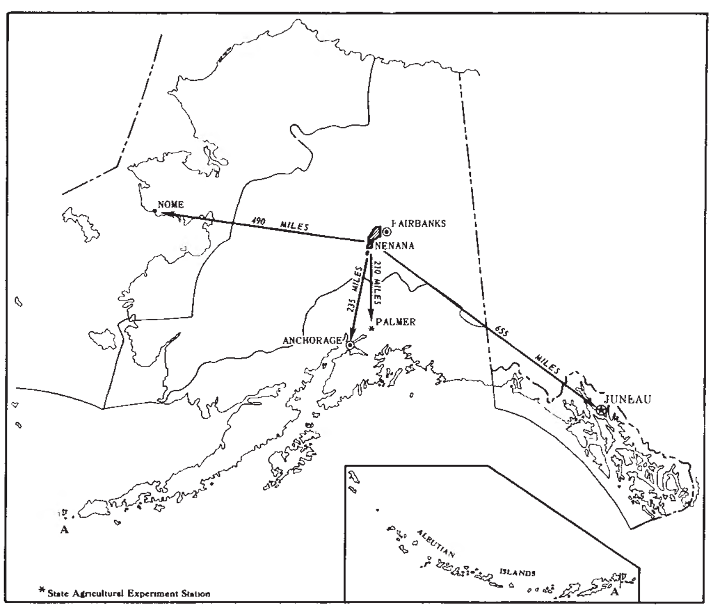

Figure 1.—**Location of the Goldstream-Nenana Area in Alaska.**

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in areas nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Fairbanks and Tanana, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soils and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Fairbanks silt loam, gently sloping, is one of several phases within the Fairbanks series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soils of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely disturbed by man that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Mine tailings is a land type in the Goldstream-Nenana Area.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, foresters, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the Goldstream-Nenana Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an Area, who want to compare different parts of an Area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in the Goldstream-Nenana Area are discussed in the following pages.

1. Fairbanks-Steese-Gilmore Association

Deep, nearly level to steep, well-drained silty soils, on upland hills and ridges

This association is on hills and ridges of the uplands above the flood plains of the Tanana River and smaller streams in the Area. The soils formed in wind-laid silty material that overlies weathered mica schist. Generally the silty material becomes thinner with increasing elevation and distance from the alluvial plains. Bedrock outcrops are common on bluffs along the streams and on ridges and peaks of high hills.

Elevation ranges from about 400 feet near Nenana to 2,364 feet at the top of Ester Dome, the highest point in the Area. At lower elevations average annual air temperature is about 26° F, and average annual precipitation is about 11 inches. No data are available for higher elevations. The frost-free period ranges from 85 to 100 days.

In this association soils that face directions other than north are well drained and are not perennially frozen. They support a mixed forest of quaking aspen, paper birch, and white spruce. Soils that have north-facing slopes receive less direct sunlight and are poorly drained, and they have permafrost at a shallow depth. They support stands of black spruce.

This association makes up about 45 percent of the survey area. Fairbanks soils make up about 45 percent of the association; Steese soils, about 20 percent; and Gilmore soils, about 20 percent. Minor soils make up about 15 percent of the association. Typical positions of the major soils are illustrated in figure 2.

Fairbanks soils have slopes with aspects other than north. These soils range from nearly level to steep. They are deep and well drained.

Steese soils have exposures comparable to those of Fairbanks soils, and they are also well drained. They are moderately deep over very channery silt loam and are gently sloping to steep.

Gilmore soils are on bluffs and on all but north-facing slopes of higher hills. They are silt loams that are shallow and very shallow over very channery silt loam. They are gently sloping to steep.

Minor soils in this association are Ester and Saulich soils on north-facing slopes.

The level to moderately sloping Fairbanks and Steese soils are the most productive soils of this association for farm crops. If cleared, fertilized, and properly managed, these soils are suitable for frost-hardy vegetables, potatoes, barley, oats, and grasses. The steep soils must remain under a permanent cover of vegetation, however, because they are susceptible to severe erosion. Ester and Saulich soils generally are too steep or too cold for cultivated crops, but in a few areas perennial grasses can be grown for hay or pasture. The Ester and Saulich soils are commonly covered by black spruce, but they are capable of producing stands of paper birch if the moss cover is removed.

2. Minto-Goldstream Association

Deep, nearly level to strongly sloping, moderately well drained silty soils, on foot slopes; and deep, nearly level to gently sloping, poorly drained silty soils with permafrost, on flood plains

This association is on the flood plains of Goldstream and Little Goldstream Creeks and the adjoining foot

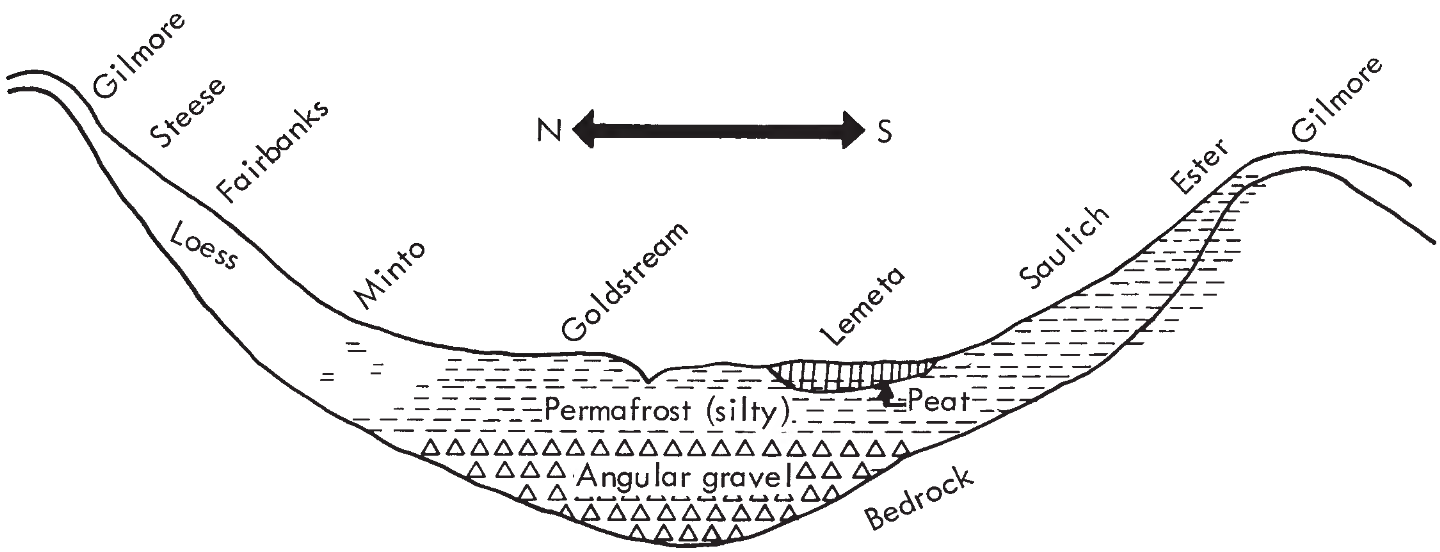

Figure **2.—Relative positions of soils, nature of soil material, and location of permafrost in associations 1 and 2.**

slopes of the uplands. The soils formed in deep silty loess and alluvium that contains either deeply buried ice masses or continuous permafrost.

Elevation ranges from 350 to 800 feet above sea level. Average annual air temperature is about 26° F, and average annual precipitation is about 11 inches. The frost-free period ranges from 85 to 100 days.

Most of the soils in this association support stands of black spruce. Paper birch and white spruce are common, however, on moderately sloping to strongly sloping, south-facing foothills. Treeless areas have a cover of low-growing shrub, sedge tussocks, and moss.

This association makes up about 22 percent of the survey area. Minto and Goldstream soils each make up about 45 percent of the association. Minor soils make about 10 percent of the association. Typical positions of the major soils are illustrated in figure 2.

Minto soils are moderately well drained silt loams on foot slopes. They are underlain by discontinuous masses of ice at depths of 6 feet or more.

Goldstream soils are poorly drained and shallow over permafrost. They are in valley bottoms and broad alluvial plains.

Minor soils in this association are Saulich soils on north-facing foot slopes and Lemeta soils in depressions in valleys.

The Minto soils potentially are the best soils for growing crops adapted to the Area. Clearing commonly results in pitting and uneven settling in these soils, but they can generally be smoothed for continued farming. Minto soils can support paper birch if the moss mat is removed. The Goldstream soils, if properly drained, are suited to some frost-hardy vegetables and grasses for hay and pasture.

3. Goldstream-Tanana Association

Deep, nearly level to gently sloping, poorly drained and somewhat poorly drained silty soils with permafrost, on flood plains

This association is on the flood plains bordering the Tanana River and Seventeenmile Slough of the Nenana River. The soils formed in water-laid silty material and are underlain by permafrost.

Elevation ranges from about 350 to about 600 feet above sea level. Average annual air temperature is about 26° F, and annual precipitation is about 11 inches. The frost-free period ranges from 85 to 100 days.

The soils of this association suppport a forest of dominantly black spruce, but paper birch, quaking aspen, white spruce, and cottonwood grow on the well-drained minor soils of this association. Treeless areas have a cover of low-growing shrubs, sedges, and moss.

This association makes up about 29 percent of the survey area. Goldstream soils make up about 50 percent of the association, and Tanana soils, about 25 percent. Minor soils make up about 25 percent of the association. Typical positions of the major soils are illustrated in figure 3.

Goldstream soils are poorly drained silt loams with permafrost. They are on lower parts of flood plains.

Tanana soils are somewhat poorly drained silt loams, and they are deeper to permafrost. These soils are on high bottoms.

Minor soils in this association are Bradway soils in old, abandoned stream channels and on low parts of the Tanana River flood plains; Goodpaster soils in areas bordering the Nenana River; Lemeta soils in muskegs; Nenana soils on stabilized sand dunes on flood plains; and Salchaket soils on natural levees.

All of the soils in this association are subject to occasional flooding. Despite this hazard, properly drained Tanana and Bradway soils are suitable for frost-hardy vegetables, grains, and grasses. Goldstream and Goodpaster soils are generally restricted to grasses even after drainage because of excess soil moisture in spring. Salchaket soils are suitable for all crops adapted to the Area, but they tend to be droughty. Lemeta soils are not suited to cultivated crops. Tanana soils can support

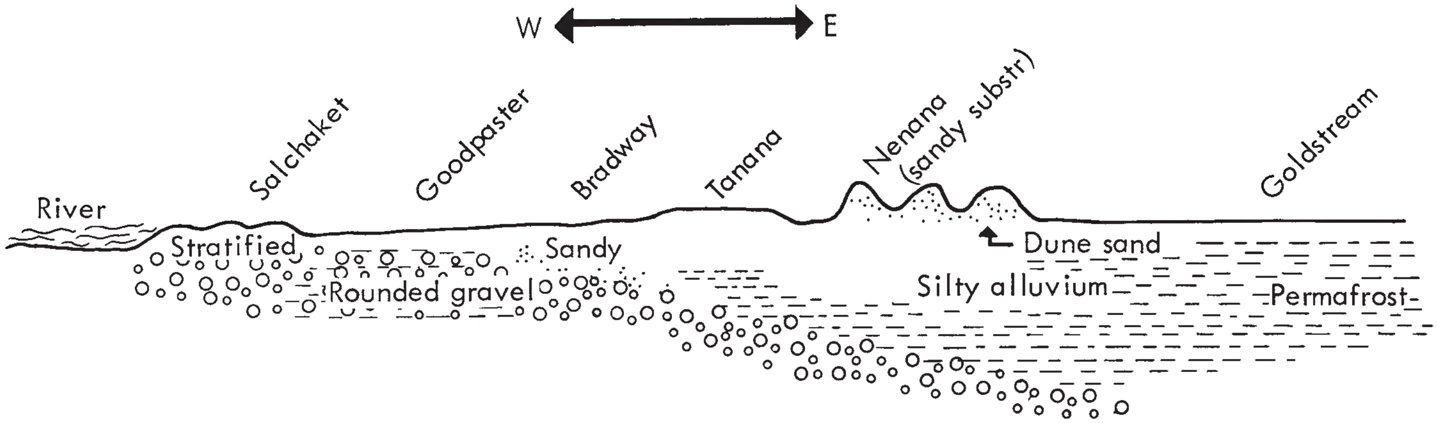

Figure 3.—**Relative positions of soils, nature of soil material, and location of permafrost in association 3.**

good stands of white spruce and birch, but only black spruce is likely to grow on Bradway, Goldstream, Goodpaster, and Lemeta soils. Salchaket soils can produce stands of white spruce and birch, but because of repeated fires, they are generally covered by willows, alder, young birch, and aspen.

4. Nenana-Tanana-Donnelly Association

Very shallow to moderately deep, nearly level to steep, well-drained and excessively drained silty soils over gravel or sand, on outwash plains and moraines; and deep, nearly level, somewhat poorly drained silty soils with permafrost, on flood plains

This association is on moraines, terraces, and high bottoms of the Nenana River in the southwestern part of the survey area. The soils formed in shallow and very shallow silty loess over gravel or sand, and in deep silty alluvium that has permafrost. Elevation ranges from about 600 to about 1,300 feet above sea level. Average annual air temperature is about 26° F, and average annual precipitation is 11 inches. The frost-free period ranges from 85 to 100 days.

The soils of this association support forests of white spruce, paper birch, and quaking aspen, or of black spruce.

This association makes up about 4 percent of the survey area. Nenana soils make up about 35 percent of the association; Tanana soils, about 25 percent; and Donnelly soils, about 25 percent. Minor soils make up about 15 percent of the association. Typical positions of the major soils are illustrated in figure 4.

Nenana soils are well drained. In this association, they are shallow, wind-laid silt loams over gravel on broad outwash plains. They are nearly level to moderately sloping.

Tanana soils are deep, somewhat poorly drained silt loams on nearly level flood plains. They are perennially frozen at a depth of about 2 to 7 feet.

Donnelly soils are excessively drained silt loams that are very shallow over gravel. They are on alluvial plains and high terraces and moraines. They are nearly level to steep.

Minor soils in this association are Salchaket soils on natural levees and Volkmar soils on terraces.

All soils in this association except Donnelly soils are suitable for cultivated crops and grasses adapted to the Area. Donnelly soils are too shallow and droughty to be used for anything but limited cultivation and pasture. Tanana soils need artificial drainage in places. Strongly sloping to steep Donnelly soils are susceptible to severe water erosion if they are cleared. Removal of the moss mat on Tanana soils generally permits natural seeding of white spruce and paper birch.

Descriptions of the Soils

This section provides detailed information about the soils in the Goldstream-Nenana Area. It describes first

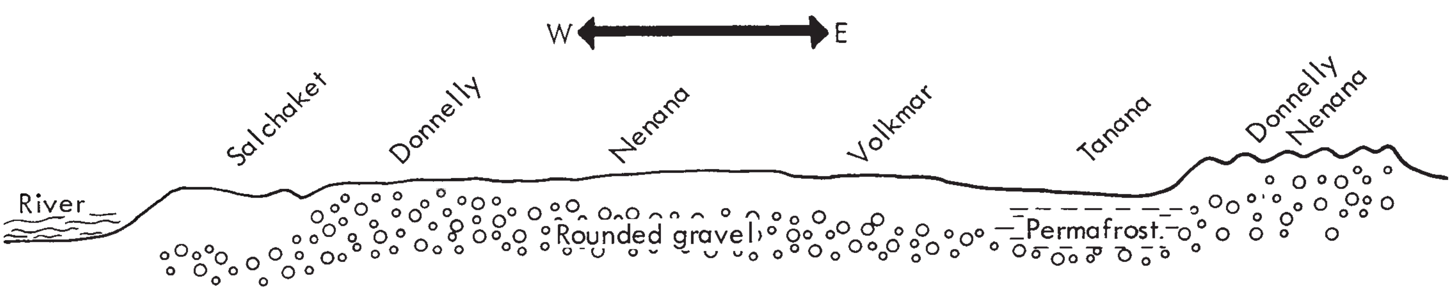

Figure 4.—**Relative positions of soils, nature of soil material, and location of permafrost in association 4.**

each soil series and then each phase or mapping unit, of the series. The soils are described in alphabetical order.

The description of a soil series mentions features that apply to all of the mapping units of that series. Differences among the mapping units of one series are pointed out in the descriptions of the individual soils or are apparent in the name.

A typical profile of each series is described in detail in the general description of the series. This profile description is for use by scientists, engineers, and others who need to make technical soil interpretations. The layers, or horizons, are designated by symbols such as A1, B21, and C1. These symbols have special meaning for soil scientists. Many readers, however, need only remember that symbols beginning with "A" are for surface layer; those with "B" are for subsoil; and those with "C" are for substratum, or parent material.

The color of each horizon is described in words, such as yellowish brown, and is also indicated by symbols for hue, value, and chroma, such as 10YR 5/4. These symbols, called Munsell color notations, are used by soil scientists to evaluate the color of the soil precisely *(13)*[1]. Unless otherwise stated, the color and consistence terms used in this survey are for moist soils.

The texture of the soil refers to the content of gravel, sand, silt, and clay. It is determined by the way the soil feels when rubbed between the fingers, and it is checked by laboratory analyses. Each mapping unit is identified by a textural class name, such as "fine sandy loam." This name refers to the texture of the surface layer, or A horizon.

The structure is indicated by the way the individual soil particles are arranged in larger grains or aggregates, and the amount of pore space between grains. The structure of the soil is described by terms that denote strength or grade, size, and shape of the aggregates. For example, a layer may consist of soil materials that have weak, fine, blocky structure.

Boundaries between horizons are described to indicate their thickness and shape. The terms for thickness are *abrupt, clear, gradual,* and *diffuse.* The shape of the boundary is described as *smooth, wavy, irregular,* or *broken.*

Other terms used for describing the soils are defined in the Glossary. For more general information about the soils, the reader can refer to the section "General Soil Map," in which broad patterns of soil are described.

Preceding the name of each mapping unit is a symbol that identifies the mapping unit or land type on the detailed map at the back of this survey. Shown at the end of the description of each mapping unit are the management group and capability classification in which the mapping unit has been placed. The page on which each is described and the page on which the woodland suitability group in which each soil has been placed are listed in the "Guide to Mapping Units." The location of the soils in the Area are shown on the detailed map at the back of this survey, and the acreage and proportionate extent of the mapping units are shown in table 1.

[1] Italic numbers in parentheses refer to Literature Cited, p. 43.

TABLE 1.—*Approximate acreage and proportionate extent of the soils.*

Soil	Acres	Percent
Bradway very fine sandy loam	2,620	0.8
Donnelly silt loam, nearly level	1,800	.6
Donnelly silt loam, gently sloping	320	.1
Donnelly silt loam, steep	670	.2
Ester silt loam, strongly sloping	410	.1
Ester silt loam, moderately steep	5,200	1.6
Ester silt loam, steep	5,990	1.8
Fairbanks silt loam, nearly level	610	.2
Fairbanks silt loam, gently sloping	4,780	1.5
Fairbanks silt loam, moderately sloping	9,450	2.9
Fairbanks silt loam, strongly sloping	17,550	5.3
Fairbanks silt loam, moderately steep	20,470	6.2
Fairbanks silt loam, steep	7,410	2.3
Gilmore silt loam, gently sloping	1,240	.4
Gilmore silt loam, moderately sloping	1,690	.5
Gilmore silt loam, strongly sloping	4,020	1.2
Gilmore silt loam, moderately steep	6,320	1.9
Gilmore silt loam, steep	8,020	2.5
Gilmore silt loam, very shallow, gently sloping	790	.2
Gilmore silt loam, very shallow, moderately sloping	310	.1
Gilmore silt loam, very shallow, moderately steep	230	.1
Gilmore silt loam, very shallow, steep	2,220	.7
Goldstream silt loam, nearly level	70,580	21.6
Goldstream silt loam, gently sloping	9,610	3.0
Goodpaster silt loam	7,370	2.3
Lemeta peat	3,520	1.1
Mine tailings	90	([1])
Minto silt loam, nearly level	3,910	1.2
Minto silt loam, gently sloping	30,700	9.4
Minto silt loam, moderately sloping	11,300	3.4
Minto silt loam, strongly sloping	2,260	.7
Nenana silt loam, nearly level	3,500	1.0
Nenana silt loam, gently sloping	160	.1
Nenana silt loam, sandy substratum, nearly level	600	.2
Nenana silt loam, sandy substratum, gently sloping	600	.2
Salchaket very fine sandy loam	13,560	4.2
Saulich silt loam, nearly level	380	.1
Saulich silt loam, gently sloping	7,390	2.3
Saulich silt loam, moderately sloping	3,740	1.2
Saulich silt loam, strongly sloping	650	.2
Saulich silt loam, moderately steep	720	.2
Saulich silt loam, steep	30	([1])
Steese silt loam, gently sloping	360	.1
Steese silt loam, moderately sloping	2,190	.7
Steese silt loam, strongly sloping	3,470	1.1
Steese silt loam, moderately steep	18,110	5.6
Steese silt loam, steep	4,250	1.3
Tanana silt loam	23,990	7.3
Volkmar silt loam	960	.3
Gravel pits	130	([1])
Total land area	326,250	100.0
Water	130	
Total	326,380	

[1] Less than 0.05 percent.

Bradway Series

The Bradway series consists of poorly drained, nearly level soils that formed in stratified silty and sandy material on low parts of flood plains and old stream channels. These soils are perennially frozen below a depth of 2 to 4 feet. The vegetation is generally a dense stand of sedges and grasses, but clumps of black spruce and shrubs grow in places.

Elevation is generally between 350 and 450 feet. Average annual air temperature is 26° F, and average annual precipitation is 11 inches. The frost-free period is 85 to 100 days.

In a typical profile a black mat of partially decomposed plant material and roots about 4 inches thick overlies a surface layer of black mucky silt loam about 2 inches thick. The subsoil is dark-gray very fine sandy loam that has dark-brown mottles and thin lenses of silt loam and fine sand. Below a depth of 36 inches, the soil material is perennially frozen and contains clear ice lenses.

Bradway soils are near Goldstream, Lemeta, Salchaket, and Tanana soils. The vegetative cover on Bradway soils provides habitat for wildlife, but unless the soils are drained, they generally are too wet for trees or vegetables.

Typical profile of Bradway very fine sandy loam, SW¼SW¼ sec. 23, T. 1 S., R. 1 E., Fairbanks Meridian:

O1—4 inches to 0, black (5YR 2/1) mat of roots, partially decomposed organic material, and charcoal; slight admixture of silt; medium acid.

A1—0 to 2 inches, black (5YR 2/1) mucky silt loam; weak, fine, granular structure; very friable; many roots; slightly acid; abrupt, wavy boundary.

B2g—2 to 36 inches, dark-gray (N 4/0) very fine sandy loam with thin lenses of silt loam and fine sand, mostly below a depth of 24 inches; many, large, prominent, dark-brown mottles; weak, thin, platy structure; very friable; few roots; mildly alkaline; water table at a depth of 18 inches; frozen at a depth of 36 inches.

The organic mat ranges from 3 to 5 inches in thickness. The A horizon is absent in places and is as much as 3 inches thick in others. The B horizon is dominantly very fine sandy loam or fine sandy loam.

Br—Bradway very fine sandy loam. This is the only Bradway soil mapped in the Area. It is in lower portions of flood plains close to the Tanana River. The soil is generally saturated, but the water table fluctuates during the summer from the surface to a few inches above the permafrost. Permeability is moderate above the permafrost. Runoff is very slow, and in spots the soil is ponded part of the growing season. The hazard of erosion is slight, but the soil is subject to occasional flooding.

Included with this soil in mapping are small tracts of Goldstream, Lemeta, Salchaket, and Tanana soils.

This soil is generally suitable for wildlife habitat, but it may be used for grain and vegetables after it is drained and the permafrost table is lowered. Management group 14 (IVw-1).

Donnelly Series

The Donnelly series consists of excessively drained, nearly level to steep soils that formed in silty material that is very shallow over very gravelly coarse sand. These soils are on outwash plains and moraines. The vegetation is dominantly paper birch, quaking aspen, and white spruce. Recently burned areas have a cover of young aspen, willow, low shrubs, and thin patches of native grasses.

Elevation ranges from 600 to 900 feet. Average annual air temperature is 26° F, and average annual precipitation is 11 inches. The frost-free period is about 85 to 100 days.

In a typical profile the surface layer is dark-brown silt loam about 1½ inches thick. The subsoil is brown silt loam and gravely silt loam that extends to a depth of about 7 inches. The substratum is very gravelly coarse sand.

The Donnelly soils commonly are near the Nenana and Tanana soils. Donnelly soils are suitable for limited cultivation and pasture.

Typical profile of Donnelly silt loam, nearly level, NE¼SW¼ sec. 12, T. 8 S., R. 9 W., Fairbanks Meridian:

O1—½ inch to 0, black (10YR 2/1) forest litter; admixture of silt; many roots; strongly acid; abrupt, smooth boundary.

A1—0 to 1½ inches, dark-brown (7.5YR 3/4) silt loam; weak, fine, granular structure; very friable; many roots; strongly acid; clear, smooth boundary.

B21—1½ to 4 inches, brown (10YR 4/3) silt loam; weak, fine, granular structure; very friable; common roots; medium acid; clear, wavy boundary.

B22—4 to 7 inches, brown (10YR 4/3) gravelly silt loam; weak, fine, granular structure; very friable; common roots; medium acid; clear, wavy boundary.

IIC—7 to 18 inches, very gravelly coarse sand; color varies with individual grains; single grained; loose; few roots; slightly acid.

Depth to gravel ranges from 5 to 10 inches. The C horizon contains cobblestones and stones in places. Reaction is medium acid to strongly acid in the layers above the gravel and ranges to slightly acid or neutral with increasing depth.

DoA—Donnelly silt loam, nearly level (0 to 3 percent slopes). This nearly level soil is on outwash plains and terraces. It has the profile described as typical for the series. Permeability is moderate in the silty material and very rapid in the underlying very gravelly coarse sand. Runoff is very slow. The hazard of water erosion is slight, and the hazard of soil blowing is moderate to severe.

Included with this soil in mapping are small tracts of Nenana soils.

This soil is wooded in most places, but some areas are suitable for pasture. Management group 13 (IVs-1).

DoB—Donnelly silt loam, gently sloping (3 to 7 percent slopes). This gently sloping soil is on outwash plains and moraines. Permeability is moderate in the silty material and very rapid in the underlying very gravelly coarse sand. Runoff is slow. The hazard of water erosion is moderate, and the hazard of soil blowing is moderate to severe.

Included with this soil in mapping are small areas of

Nenana and Tanana soils. Also included are small areas of steeper Donnelly soils.

This soil is wooded in most places. In cleared areas, this soil has only limited potential for growing cultivated crops. Management group 12 (IVe-2).

DoF—Donnelly silt loam, steep (12 to 45 percent slopes). This strongly sloping to steep soil is on moraines. Permeability is moderate in the silty material and very rapid in the underlying very gravelly coarse sand. Runoff is medium to rapid. The hazard of erosion is severe to very severe.

Included with this soil in mapping are small areas of Nenana soils and less steep Donnelly soils.

This soil is useful for wildlife habitat and watershed protection. Management group 18 (VIIe-1).

Ester Series

The Ester series consists of poorly drained, strongly sloping to steep soils that formed in silty loess on north-facing slopes. Permafrost is at a shallow depth. The vegetation is dominantly black spruce, shrubs, and moss, but paper birch grows in areas that have been severely burned.

Elevation ranges from 600 to 1,500 feet. Average annual air temperature is 26° F, and annual precipitation is 11 inches. The frost-free period is about 85 to 100 days.

In a typical profile a layer of peat and roots about 14 inches thick overlies a surface layer of very dark gray silt loam, 4 inches thick, that has clear ice lenses. The substratum is dark-gray very channery silt loam that has dark-brown mottles and that grades with depth to shattered schist.

Ester soils generally are near Gilmore, Saulich, and Steese soils. They are useful for wildlife habitat and watershed protection.

Typical profile of Ester silt loam, moderately steep, SW¼NW¼ sec. 1, T. 2 S., R. 4 W., Fairbanks Meridian:

O11—14 inches to 7, dark yellowish-brown (10YR 4/4) sphagnum moss, pink (7.5YR 7/4) when pressed; 100 percent fiber after rubbing; many roots; very strongly acid; abrupt, smooth boundary.

O12—7 inches to 4, dark reddish-brown (5YR 2/2) moss peat, reddish brown (5YR 4/3) when pressed; 100 percent fiber after rubbing; many roots; very strongly acid; abrupt, smooth boundary.

O13—4 inches to 0, very dark grayish-brown (10YR 3/2) moss peat, dark brown (10YR 4/3) when pressed; 80 percent fiber, 40 percent after rubbing; many roots; very strongly acid; abrupt, smooth boundary.

A1f—0 to 4 inches, very dark gray (5Y 3/1) silt loam; frozen with clear ice lenses; no live roots; strongly acid; abrupt, wavy boundary.

Cf—4 to 9 inches, dark-gray (5Y 4/1) very channery silt loam; common, distinct, dark-brown (10YR 3/3) mottles; frozen with clear ice lenses; no roots; strongly acid.

The organic mat of moss and roots ranges from 6 to 16 inches in thickness. The silt loam mantle is 4 to 20 inches thick. Reaction ranges from extremely acid in the A horizon to medium acid in the C horizon. Consolidated schist is below a depth of 48 inches in places.

In places the soils have a thin, gray horizon immediately below the organic mat and mottles of higher value and chroma in the lower horizons. Permafrost is below a depth of 20 inches. The vegetation on such soils generally includes young birch, alder, willow, and grass.

EsD—Ester silt loam, strongly sloping (12 to 20 percent slopes). This soil is on north-facing slopes of ridges and hills. It has a profile similar to the one described as typical for the series, except the silt loam mantle is generally a little thicker than the one in that profile. Permeability is moderate. Runoff is medium in most areas but is rapid in severely burned or cleared areas. The hazard of erosion is severe.

Included with this soil in mapping are small areas of Gilmore and Steese soils and, in a few places, Saulich soils. Also included are a few spots of rock outcrop.

This soil is useful for wildlife habitat and watershed protection. Management group 19 (VIIw-1).

EsE—Ester silt loam, moderately steep (20 to 30 percent slopes). This soil is on long, north-facing slopes of hills and ridges. It has the profile described as typical for the series. Permeability is moderate. The hazard of erosion is very severe in areas where vegetation has been burned off.

Included with this soil in mapping are small areas of Gilmore, Saulich, and Steese soils. Also included are a few spots of rock outcrop.

This soil is useful for wildlife habitat and watershed protection. Management group 19 (VIIw-1).

EsF—Ester silt loam, steep (30 to 45 percent slopes). This soil is on north-facing slopes of high ridges and hills. Permeability is moderate. It is susceptible to very severe erosion if the vegetation is burned or cleared.

Included with this soil in mapping are small areas of Gilmore, Saulich, and Steese soils and a few spots of rock outcrop.

This soil is useful for wildlife habitat and watershed protection. Management group 19 (VIIw-1).

Fairbanks Series

The Fairbanks series consists of deep, well-drained, nearly level to steep silty soils that formed in loess. These soils are on all but north-facing slopes of hills and on the tops of ridges. The vegetation is commonly a forest of white spruce, paper birch, and quaking aspen, in pure or mixed stands. Birch and aspen dominate in burned or cutover areas.

Elevation ranges from 400 to 1,200 feet. Average annual air temperature is 26° F, and average annual precipitation is 11 inches. The frost-free period is 85 to 100 days.

In a typical profile a black, partially decomposed mat of forest litter about 3 inches thick overlies a mineral surface layer about 8 inches thick. It is dark-brown silt loam in the upper 3 inches and brown silt below. The subsoil is dark-brown silt about 13 inches thick. It contains thin, roughly horizontal bands of dark-brown fine silt loam. The substratum is grayish-brown silt.

Fairbanks soils are near Gilmore and Steese soils on uplands and in places are adjacent to the Goldstream, Minto, Saulich, and Tanana soils in valleys and on foot slopes. The Fairbanks soils are generally forested. On lower slopes they are suitable for all adapted crops and pasture.

Typical profile of Fairbanks silt loam, nearly level, NE¼NE¼ sec. 29, T. 2 S., R. 5 W., Fairbanks Meridian:

O1—3 inches to 0, black (10YR 2/1), partially decomposed forest litter; many roots; medium acid; abrupt, smooth boundary.
A1—0 to 3 inches, dark-brown (10YR 4/3) silt loam; weak, very fine, granular structure; very friable; many roots; slightly acid; abrupt, wavy boundary.
A2—3 to 8 inches, brown (10YR 5/3) silt (color on plate faces is ½ value step higher than on plate edges); weak, very thin, platy structure; very friable; common roots; slightly acid; clear, wavy boundary.
B2—8 to 21 inches, dark-brown (10YR 4/3) silt, many thin, roughly horizontal bands of dark-brown (10YR 3/3) fine silt loam forking and merging in irregular pattern with a thin layer, ¼ to ½ inch thick, of brown (10YR 5/3) silt above each band; weak, very thin, platy structure, but structure in bands is weak, very fine, angular blocky; friable; common roots; slightly acid; abrupt, smooth boundary.
C—21 to 40 inches, grayish-brown (10YR 5/2) silt, many horizontal streaks of dark yellowish brown (10YR 4/4) and few streaks of very dark grayish brown (10YR 3/2); weak, very thin, platy structure; very friable; few roots; slightly acid.

The loess is 40 inches to many feet thick over bedrock. The soil material is generally silt loam or silt throughout, but in places the B horizon is very fine sandy loam. In places, a thin, grayish-brown horizon is immediately below the organic mat. Reaction ranges from strongly acid to slightly acid in the A horizon and from medium acid to slightly acid in the B horizon. The B horizon contains fine silt loam in bands that range in thickness from ⅛ to ¼ inch. These bands undulate in an irregular pattern, but they are generally nearly horizontal. In places a horizon of fine sand up to several feet thick is below a depth of 36 inches. On a few bluffs along Goldstream Creek and the Tanana River, this soil is not as brown as it is in other parts of the Area.

FaA—Fairbanks silt loam, nearly level (0 to 3 percent slopes). This soil is only in two tracts that adjoin steeper Fairbanks soils. It has the profile described as typical for the series. Permeability is moderate. Runoff is slow. The hazard of water erosion is slight.

This oil is used for frost-hardy vegetables, small grains, and pasture. Management group 1 (IIc-1).

FaB—Fairbanks silt loam, gently sloping (3 to 7 percent slopes). This soil is on ridgetops and foot slopes. On ridges, it is generally bounded by steeper Fairbanks soils, and on foot slopes, it is generally bounded by Minto soils on its lower boundary and by steeper Fairbanks soils on its upper boundary. Permeability is moderate. Runoff is medium. The hazard of water erosion is slight to moderate.

Included with this soil in mapping are a few small areas of Minto soils and steeper Fairbanks soils.

This soil is suitable for small grains, grasses, and vegetables. Management group 3 (IIe-1).

FaC—Fairbanks silt loam, moderately sloping (7 to 12 percent slopes). This soil is on ridges and lower slopes of hills. On ridges, it is generally bounded by steeper Fairbanks soils, and on lower slopes, it generally borders Goldstream and Minto soils on its lower boundary and steeper Fairbanks soils on its upper boundary. Permeability is moderate. Runoff is medium in burned or cleared areas. The hazard of water erosion is moderate.

Included with this soil in mapping are small tracts of Goldstream and Minto soils and steeper Fairbanks soils.

This soil is suitable for small grains, grasses, and vegetables. Management group 5 (IIIe-1).

FaD—Fairbanks silt loam, strongly sloping (12 to 20 percent slopes). This soil is in the middle of slopes on long hillsides and on lower slopes. It is commonly dissected by many small draws. In some places bedrock is within a depth of 50 inches. Permeability is moderate. Runoff is rapid in burned or cleared areas. The hazard of water erosion is severe.

Included with this soil in mapping are small tracts of Gilmore, Goldstream, Minto, and Saulich soils. Also included are small areas of moderately sloping and moderately steep Fairbanks soils.

Because of its slope, this soil has limited potential for growing cultivated crops. It is used mainly for woodland and wildlife habitat. Management group 11 (IVe-1).

FaE—Fairbanks silt loam, moderately steep (20 to 30 percent slopes). This soil is on long side slopes of hills. It is commonly dissected by many draws. Permeability is moderate. Runoff is rapid where the vegetation has been burned or cleared. The hazard of water erosion is severe.

Included with this soil in mapping are small areas of Gilmore, Steese, and Saulich soils. Also included are a few areas of strongly sloping and steep Fairbanks soils.

This soil is used mainly for woodland and wildlife habitat. It is too steep for cultivated crops, but if cleared, it is suitable for perennial grasses for hay and pasture. Management group 16 (VIe-1).

FaF—Fairbanks silt loam, steep (30 to 45 percent slopes). This soil is generally on upper slopes of high hills, but in places it is on long middle slopes. Permeability is moderate. Runoff is rapid where the vegetation has been removed. The hazard of soil erosion is very severe.

Included with this soil in mapping are small tracts of Gilmore and Steese soils. Also included are small areas of less steep Fairbanks soils.

This soil is used mainly for woodland and wildlife habitat. Management group 18 (VIIe-1).

Gilmore Series

The Gilmore series consists of well-drained, gently sloping to steep soils that formed in shallow and very shallow deposits of silty loess that overlies very channery silt loam. These soils generally are on the upper slopes and ridges of high hills. The vegetation is dominantly paper birch, quaking aspen, and in recently burned areas, white spruce.

Elevation ranges from 400 to 2,300 feet. Average annual air temperature is 26° F, and average annual precipitation is 11 inches. The frost-free period ranges from 85 to 100 days.

In a representative profile a dark reddish-brown mat of forest litter and peat overlies a surface layer of dark-brown silt loam about 4 inches thick. The subsurface layer is 3 inches of yellowish-brown silt. The subsoil is dark yellowish-brown silt about 7 inches thick. It contains one or more very thin bands of dark-brown fine silt loam. It is underlain by olive very channery silt loam that grades with depth to consolidated mica schist.

Gilmore soils commonly are near Ester, Fairbanks, and Steese soils. Deeper Gilmore soils are potentially suitable for growing most crops adapted to the Area.

Typical profile of Gilmore silt loam, gently sloping, NW¼SW¼ sec. 1, T. 2 S., R. 4 W., Fairbanks Meridian:

O1—3 to 0 inches, dark reddish-brown (5YR 2/2) forest litter and hypnum moss peat; many roots; mycelia; medium acid; abrupt, smooth boundary.

A1—0 to 4 inches, dark-brown (7.5YR 4/4) silt loam; weak, very fine, granular structure; very friable; many roots; medium acid; abrupt, wavy boundary.

A2—4 to 7 inches, yellowish-brown (10YR 5/4) silt; few patches are dark yellowish brown (10YR 4/4); weak, very thin, platy structure; very friable; common roots; medium acid; abrupt, smooth boundary.

B2—7 to 14 inches, dark yellowish-brown (10YR 4/4) silt; discontinuous band of dark-brown (10YR 4/3) fine silt loam near top of horizon; weak, very thin, platy structure; very friable; few roots; medium acid; clear, smooth boundary.

IIC—14 to 24 inches, olive (5Y 4/3) very channery silt loam; massive; no roots; schist fragments make up 65 percent of soil volume; slightly acid.

The mantle of silt loam and silt is 5 to 20 inches thick over very channery silt loam. Reaction ranges from strongly acid to slightly acid. A thin grayish-brown horizon is immediately below the organic mat in places. Consolidated mica schist is below a depth of 48 inches in most places, but outcrops of bare rock are common.

GmB—Gilmore silt loam, gently sloping (3 to 7 percent slopes). This soil is on a few ridgetops. It has the profile described as typical for the series. Permeability is moderate. Runoff is slow to medium. The hazard of water erosion is slight to moderate.

Included with this soil in mapping are small tracts of Ester and Steese soils. Also included are small areas of steeper Gilmore silt loams and spots of Gilmore soils that are very shallow over very channery material.

This soil is wooded in most places. If cleared, it is suitable for most crops adapted to the Area. Management group 8 (IIIe-4).

GmC—Gilmore silt loam, moderately sloping (7 to 12 percent slopes). This soil is on ridgetops. It is generally adjacent to steeper Ester, Steese, or Gilmore soils. Runoff is medium. Permeability is moderate. The hazard of water erosion is moderate.

Included with this soil in mapping are small tracts of Ester and Steese soils. Also included are small areas of strongly sloping Gilmore soils.

This soil is wooded in most places. If cleared, it is suitable for crops adapted to the Area. Management group 12 (IVe-2).

GmD—Gilmore silt loam, strongly sloping (12 to 20 percent slopes). This soil is generally on high ridges. It borders Ester soils on north-facing slopes and Steese soils or more steeply sloping Gilmore soils on slopes facing other directions. Runoff is medium to rapid. Permeability is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are a few areas of Gilmore silt loam, moderately steep, Gilmore silt loam, steep, and Ester and Steese soils. Also included are a few small tracts of Gilmore soils that are very shallow to very channery material.

This soil is forested in most places. If cleared, it is suitable for perennial grasses for hay and pasture. Management group 12 (IVe-2).

GmE—Gilmore silt loam, moderately steep (20 to 30 percent slopes). This soil is on middle and upper slopes of high hills. It is generally bounded by Steese soils and by other Gilmore soils. In some areas it is contiguous to Ester or Fairbanks soils. Permeability is moderate. Runoff is rapid where the soil is cleared. The hazard of water erosion is severe.

Included with this soil in mapping are a few areas of Ester, Fairbanks, and Steese soils. Also included are rock outcrops, spots of steeper and less steep Gilmore silt loams, and spots of Gilmore soils that are very shallow to very channery material.

This soil is forested in most places. If cleared, it is suitable only for perennial grasses for pasture. Management group 16 (VIe-1).

GmF—Gilmore silt loam, steep (30 to 45 percent slopes). This steep soil has a profile similar to the one described as typical for the series, except it is commonly somewhat shallower over very channery material than less steep Gilmore soils. Permeability is moderate. Runoff is very rapid if the soil is cleared. The hazard of water erosion is very severe.

Included with this soil in mapping are a few small areas of Steese soils. Also included are a few rock outcrops and a few small areas of less steep Gilmore silt loams.

The natural vegetation on this soil is forest. If cleared, the soil is useful only as permanent pasture. Management group 18 (VIIe-1).

GrB—Gilmore silt loam, very shallow, gently sloping (3 to 7 percent slopes). This soil is on high ridges. The profile of this very shallow Gilmore soil differs from the profile of the typical Gilmore soil by having less than 10 inches of loess over very channery material. Permeability is moderate. Runoff is slight to medium. The hazard of erosion is moderate.

Included with this soil in mapping are a few small tracts of Ester soils and deeper Gilmore soils. Also included are small areas of steeper very shallow Gilmore soils and rock outcrops.

The vegetation on this soil is stunted in most places. The soil is useful mostly as wildlife habitat. Management group 12 (IVe-2).

GrC—Gilmore silt loam, very shallow, moderately sloping (7 to 20 percent slopes). This soil is in a few areas on high ridges. The profile of this very shallow Gilmore soil differs from the profile of the typical Gilmore soil by having less than 10 inches of loess over very channery material. Permeability is moderate. Runoff is medium to rapid. The hazard of water erosion is moderate to severe.

Included with this soil in mapping are small areas of steeper Gilmore soils, Steese soils, and rock outcrops.

The vegetation on this soil is stunted. This soil is useful only as wildife habitat. Management group 16 (VIe-1).

GrE—Gilmore silt loam, very shallow, moderately steep (20 to 30 percent slopes). This soil is on high hillsides. The profile of this very shallow Gilmore soil differs from the profile of the typical Gilmore soil by

having less than 10 inches of loess over very channery material. Permeability is moderate. Runoff is rapid. The hazard of water erosion is severe.

Included with this soil in mapping are small areas of Steese soils and rock outcrops. Also included are small tracts of Gilmore soils that have a silty mantle thicker than 10 inches.

The vegetation on this soil is a stunted forest of paper birch or quaking aspen in most places. This soil is useful mostly as wildlife habitat. Management group 18 (VIIe-1).

GrF—Gilmore silt loam, very shallow, steep (30 to 45 percent slopes). This soil is on the sides of steep hills and bluffs. The profile of this very shallow Gilmore soil differs from the profile of the typical Gilmore soil by having less than 10 inches of loess over very channery material. Permeability is moderate. Runoff is very rapid. The hazard of water erosion is very severe.

Included with this soil in mapping are a few small areas of Ester and Steese soils, rock outcrops, and deeper Gilmore soils.

The vegetation includes stunted paper birch, quaking aspen, and brush. This soil is useful mainly as wildlife habitat. Management group 18 (VIIe-1).

Goldstream Series

The Goldstream series consists of poorly drained, nearly level to gently sloping soils that formed in deep silty alluvium. These soils are perenially frozen at a shallow to moderate depth. They are on broad flood plains and valley bottoms on uplands. The vegetation includes black spruce, low shrubs, mosses, and sedge tussocks that are 12 to 18 inches in diameter and up to 18 inches in height. Elevation is generally 350 to 600 feet. Average annual air temperature is 26° F, and average annual precipitation is 11 inches. The frost-free period is 85 to 100 days.

In a typical profile a dark reddish-brown and black mat of mosses, roots, and partly decomposed organic matter about 10 inches thick overlies a layer of mottled, dark greenish-gray silt loam that contains streaks and pockets of organic matter. Permafrost is 28 inches below the surface of the mineral soil.

Goldstream soils commonly are near Goodpaster, Nenana, Salchaket, and Tanana soils on broad alluvial plains and Lemeta, Minto, and Saulich soils in upland valleys. Generally, the Goldstream soils are too cold for trees or crops, but if the surface mat is removed and adequate drainage is provided, the permafrost table may be lowered and the soils warmed sufficiently for grass and some vegetable crops.

Typical profile of Goldstream silt loam, nearly level, NE½SE¼ sec. 20, T. 1 N., R. 3 W., Fairbanks Meridian:

O1—10 inches to 2, dark reddish-brown (5YR 3/2) fibrous hypnum moss peat, brown (7.5YR 5/3) pressed; many roots; strongly acid; abrupt, smooth boundary.

O2—2 inches to 0, black (N 2/0), finely divided organic matter; many roots; charcoal; strongly acid; clear, wavy boundary.

B21g—0 to 10 inches, dark greenish-gray (5GY 4/1) silt loam; many black (N 2/0) streaks and coarse, distinct, dark-brown (10YR 4/3) mottles; massive; friable; common roots; very strongly acid; gradual boundary.

B22g—10 to 28 inches, dark greenish-gray (5GY 4/1) silt loam; common, medium, distinct, dark grayish-brown (2.5Y 4/2) mottles and few streaks and pockets of black (N 2/0) organic material; massive; friable; few roots in the upper part; very strongly acid; abrupt, smooth boundary.

B23gf—28 to 36 inches, similar to horizon above, but frozen with clear ice lenses; very strongly acid.

The organic mat is 6 to 14 inches thick. A dark, mixed mineral and organic horizon is beneath the mat in places. Lenses of fine sand are in the soil material in places. Permafrost is 10 to 30 inches below the surface of the mineral soil.

GtA—Goldstream silt loam, nearly level (0 to 3 percent slopes). This nearly level soil is in large areas on broad alluvial plains and in valleys on uplands. It has the profile described as typical for the series. Permeability is moderate above permafrost. Runoff is very slow. The hazard of erosion is slight.

Included with this soil in mapping on broad alluvial plains are a few small areas of Nenana, Salchaket, and Tanana soils. Small tracts of Lemeta, Minto, and Saulich soils are included in upland valleys.

The native vegetation is useful only as habitat for wildlife. Hardy early-maturing vegetables and grasses for hay and pasture can be grown on this soil where it is adequately drained. Management group 14 (IVw-1).

GtB—Goldstream silt loam, gently sloping (3 to 12 percent slopes). This soil is in valley bottoms on uplands. Permeability is moderate above the permafrost. Runoff is slow to medium. The hazard of erosion is slight to moderate.

Included with this soil in mapping are small tracts of Minto and Saulich soils. Also included are small areas of Fairbanks soils on the adjoining foot slopes.

The native vegetation is useful only as wildlife habitat. Hardy early-maturing vegetables and grasses for hay and pasture plants can be grown on this soil where it is adequately drained. Management group 15 (IVw-2).

Goodpaster Series

The Goodpaster series consists of poorly drained, nearly level silty soils that are shallow to moderately deep over very gravelly sand. These soils have a thick organic layer at the surface, but the permafrost table is deep. They are exclusively on low terraces near Seventeenmile Slough of the Nenana River. The vegetation includes black spruce, dwarf birch, willow, sedges, and mosses.

Elevation ranges from 350 to 600 feet. Average annual air temperature is 26° F, and average annual precipitation is 11 inches. The frost-free period is 85 to 100 days.

In a typical profile a dark-brown and black mat of moss, peat, and roots, about 9 inches thick, overlies a layer of olive-gray silt loam that has olive mottles and black organic streaks. The substratum of very gravelly coarse sand is at a depth of about 15 inches.

The Goodpaster soils are near the Donnelly, Goldstream, Salchaket, and Tanana soils. Where cleared and adequately drained, the Goodpaster soils are suitable for frost-hardy vegetables and for hay and pasture.

Typical profile of Goodpaster silt loam, SE¼NE¼ sec. 32, T. 6 S., R. 8 W., Fairbanks Meridian:

O11—9 inches to 4, dark-brown (7.5YR 4/4) hypnum moss peat; no change in color by pressing; nearly 100 percent fiber after rubbing; many roots; medium acid; abrupt, smooth boundary.

O12—4 inches to 0, black (5YR 25/1) moss peat; no color change by pressing; about 95 percent fiber after rubbing; many roots; slightly acid; abrupt, irregular boundary.

B2—0 to 15 inches, olive-gray (5Y 5/2) silt loam with irregular streaks of sandy loam; many, coarse, faint, olive (5Y 5/3) mottles; black (N 2/0) streaks, especially in upper part; massive; friable; no roots; patches of frozen soil in lower part of horizon; medium acid; abrupt, wavy boundary.

IIC—15 to 25 inches, very gravelly coarse sand; colors vary with individual grains; single grained; loose; no roots.

The depth to very gravelly coarse sand ranges from 15 to 27 inches. The B horizon contains some cobbles in places.

GuA—Goodpaster silt loam (0 to 3 percent slopes). This is the only Goodpaster soil mapped in the Area. It is in one large area on low terraces. Permeability is moderate in the silt loam and very rapid in the underlying gravelly coarse sand. Runoff is very slow. The hazard of water erosion is slight.

Included with this soil in mapping are small tracts of Donnelly, Goldstream, Salchaket, and Tanana soils.

If cleared and adequately drained, frost-hardy vegetables and grasses for hay and pasture can be grown. Management group 14 (IVw-1).

Lemeta Series

The Lemeta series consists of very poorly drained, nearly level organic soils made up of sphagnum moss with strata of sedge peat. These nearly level soils are in flat or slightly domed muskegs. Permafrost is at a shallow depth. The vegetation is dominantly sphagnum moss with low shrubs, sedges, and in places, black spruce.

Elevation ranges from 350 to 600 feet. Average annual air temperature is 26° F, and average annual precipitation is 11 inches. The frost-free period is 85 to 100 days.

In a typical profile peat is more than 60 inches thick. Sphagnum and sedge peat are both fibrous, and they are dark reddish brown under natural conditions. The peat derived from sphagnum becomes yellowish red when the water is removed.

Lemeta soils are near Goldstream, Minto, Saulich, and Tanana soils. Lemeta soils do not support commercial stands of timber, and they are not suitable for cultivated crops.

Typical profile of Lemeta peat, NE¼SE¼ sec. 20, T. 1 N., R. 3 W., Fairbanks Meridian:

Oi1—0 to 11 inches, reddish-brown (5YR 4/4) sphagnum moss peat, pink (5YR 7/3) when pressed; 100 percent fiber after rubbing; loose mat; many roots; extremely acid in water; abrupt, smooth boundary.

Oi2—11 to 13 inches, dark reddish-brown (5YR 3/2) moss and sedge peat, dark reddish brown (5YR 3/3) when pressed; 100 percent fiber, 90 percent after rubbing; weakly laminated; many roots; very strongly acid in water; abrupt, smooth boundary.

Oi3—13 to 23 inches, dark reddish-brown (5YR 3/4) sphagnum moss peat, dark brown (7.5YR 4/4) rubbed, yellowish red (7.5YR 5/6) pressed; arranged in thin, cohesive layers; no live roots; very strongly acid in water; abrupt, smooth boundary.

Oi4—23 to 32 inches, dark reddish-brown (5YR 2/2) sedge peat, dark reddish brown (5YR 3/2) rubbed, dark reddish brown (5YR 3/3) pressed; arranged in thin, cohesive layers; no live roots; very strongly acid in water. Frozen below a depth of 32 inches.

The peat is always more than 60 inches thick, and in places, it extends to a depth of 100 inches or more. The water table is always at or near the surface. Permafrost is at a depth of 15 to 36 inches.

Lp—Lemeta peat. This is the only Lemeta soil mapped in the Area. Permeability is moderately rapid. Runoff is very slow to ponded. The hazard of water erosion is none to slight.

Included with this soil in mapping are small tracts of Goldstream, Minto, Saulich, and Tanana soils. Also included are a few small ponds.

The natural vegetation on the Lemeta soils is useful only as wildlife habitat. This soil is not suitable for commercial forest or cultivated crops. Management group 20 (VIIw-2).

Mine Tailings

Me—Mine tailings. This land type consists of mounds of gravelly rubble deposited by gold dredges in Nugget Creek and some tributaries of the Tanana River. The silty overburden above the gold-bearing gravel was formerly many feet thick, but it was removed hydraulically before dredging operations began. Management group 21 (VIIIs-1).

Minto Series

The Minto series consists of moderately well drained, deep, nearly level to strongly sloping soils that formed in silty loess that commonly contains large masses of ice below a depth of 6 feet. These soils are on low knolls and ridges in valleys and on foot slopes of hills. The vegetation is dominantly paper birch, quaking aspen, and white spruce, but many areas support black spruce and willows.

Elevation ranges from 400 to 800 feet. Average annual air temperature is 26° F, and average annual precipitation is 11 inches. The frost-free period is about 85 to 100 days.

In a typical profile a dark reddish-brown mat of partially decomposed organic matter and roots 5 inches thick overlies a surface layer of very dark grayish-brown silt loam about 3 inches thick. The subsoil consists of irregular streaks and patches of gray and dark-brown silt about 16 inches thick. The substratum is gray silt streaked with dark brown.

Minto soils are near Fairbanks, Goldstream, Saulich, and Tanana soils. Many areas of Minto soils support forests that have commercial value. Frost-hardy vegetables, perennial grasses, oats, and barley can be grown on these soils.

Typical profile of Minto silt loam, nearly level, NE¼NE¼ sec. 20, T. 1 N., R. 3 W., Fairbanks Meridian:

O1—5 inches to 0, dark reddish-brown (5YR 2/2) forest litter; many roots; charcoal fragments; mycelia in

lower part; very strongly acid; abrupt, smooth boundary.

A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) silt loam; patches of dark grayish brown (10YR 4/2); weak, very fine, granular structure; very friable; many roots; strongly acid; clear, smooth boundary.

B21—3 to 10 inches, gray (10YR 5/1) and dark-brown (10YR 4/3) silt in irregular streaks and patches, each making up about 50 percent of the soil mass; weak, very thin, platy structure; very friable; common roots; medium acid; gradual boundary.

B22—10 to 19 inches, dark-brown (10YR 3/3) and gray (10YR 5/1) silt in irregular streaks and patches with dark brown making up about 60 percent of the soil mass; weak, very thin, platy structure; very friable; few roots; medium acid; gradual boundary.

C—19 to 40 inches, gray (10YR 5/1) silt with roughly horizontal streaks of dark brown (7.5YR 4/4) making up about 25 percent of the soil mass; weak, very thin, platy structure; very friable; no roots; neutral.

MnA—Minto silt loam, nearly level (0 to 3 percent slopes). This soil is on low knolls in broad valleys. It has the profile described as typical for the series. Fewer thermokarst lakes are on this soil than are on Minto silt loam, gently sloping. Permeability is moderate. Runoff is slow. The hazard of water erosion is slight. Removal of the vegetation and the organic surface layer increases uneven settling or pitting because of melting of buried ice masses.

Included with this soil in mapping are small areas of Goldstream and Saulich soils and steeper Minto soils. Also included are a few small tracts of Fairbanks soils.

This soil can produce commercial timber if no thick moss mat is present. If the soil is cleared, frost-hardy vegetables, potatoes, perennial grasses, barley, and oats can be grown. Management group 2 (IIc-2).

MnB—Minto silt loam, gently sloping (3 to 7 percent slopes). This soil is on foothills. In places, thermokarst lakes are fairly common. Permeability is moderate. Runoff is slow. The hazard of water erosion is slight to moderate. Clearing this soil causes uneven settling or pitting because of melting ice masses.

Included with this soil in mapping are small tracts of Fairbanks, Goldstream, and Saulich soils. Also included are a few small areas of Tanana soils and steeper Minto soils.

Commercial timber can be grown on this soil if no moss mat is present. Frost-hardy vegetables, potatoes, perennial grasses, barley, and oats can be grown in cleared areas. Management group 4 (IIe-2).

MnC—Minto silt loam, moderately sloping (7 to 12 percent slopes). This soil is on foot slopes of high hills. Small, steep-sided thermokarst pits are in a few places. Permeability is moderate. Runoff is medium. The hazard of water erosion is moderate. Clearing this soil causes uneven settling or pitting because of melting ice masses.

Included with this soil in mapping are a few tracts of Fairbanks, Goldstream, and Saulich soils. Also included are a few areas of less steep Minto soils.

Commercial timber can be grown on this soil if no moss mat is present. If the soil is cleared, cultivated crops, perennial grasses, barley, and oats can be grown. Management group 6 (IIIe-2).

MnD—Minto silt loam, strongly sloping (12 to 20 percent slopes). This soil is on foot slopes of high hills. Permeability is moderate. Runoff is rapid. The hazard of water erosion is severe. Clearing this soil causes uneven settling or pitting because of melting ice masses.

Included with this soil in mapping are a few small tracts of Fairbanks, Saulich, and Steese soils. Also included are a few small areas of Minto silt loam, moderately sloping.

This soil supports a forest of paper birch and white spruce, and tall willow brush grows in depressions. If cleared, it is used for perennial grasses and pasture. Management group 11 (IVe-1).

Nenana Series

The Nenana series consists of well-drained soils that formed in silty loess that is shallow to moderately deep over a substratum of sand or very gravelly sand. These soils are nearly level to moderately sloping on broad outwash plains and nearly level to undulating on dunes on flood plains. The vegetation includes paper birch, quaking aspen, and white spruce.

Elevation ranges from 600 to 1,300 feet. Average annual air temperature is 26° F, and average annual precipitation is 11 inches. The frost-free period is 85 to 100 days.

In a typical profile, a black organic mat, 1 inch thick, overlies a surface layer of dark grayish-brown silt loam about 2 inches thick. The subsoil is dark yellowish-brown and dark-brown silt loam about 13 inches thick. The substratum to a depth of 20 inches is yellowish-brown gravelly silt loam. Below this, it is very gravelly coarse sand.

Nenana soils are only in the extreme southwestern part of the Area. They are near Donnelly, Goldstream, Salchaket, Tanana, and Volkmar soils. Forests on the Nenana soils have commercial potential, but most are in burned-over areas and are now too young. If cleared, these soils can be used for cultivated crops and perennial grasses.

Typical profile of Nenana silt loam, nearly level, SW¼NW¼ sec. 5, T. 8 S., R. 8 W., Fairbanks Meridian:

O1—1 inch to 0, black (10YR 2/1) forest litter; admixture of silt; many roots; very strongly acid; abrupt, smooth boundary.

A2—0 to 1½ inches, dark grayish-brown (2.5Y 4/2) silt loam; weak, very fine, granular structure; very friable; common roots; medium acid; abrupt, wavy boundary.

B21—1½ to 10 inches, dark yellowish-brown (10YR 4/4) silt loam; weak, very thin, platy structure; very friable; common roots; medium acid; clear, wavy boundary.

B22—10 to 15 inches, dark-brown (10YR 4/3) silt loam; moderate, thin, platy structure; very friable; common roots; medium acid; clear, wavy boundary.

C1—15 to 20 inches, yellowish-brown (10YR 5/4) gravelly silt loam; moderate, very thin, platy structure; very friable; few roots; somewhat more micaceous than horizons above; medium acid; abrupt, wavy boundary.

IIC2—20 to 30 inches, very gravelly coarse sand; color varies with individual grains; single grain; loose; no roots; slightly acid.

The silt loam mantle is about 10 to 25 inches thick over very gravelly coarse sand or sands. Reaction ranges from

medium acid in the silty material to neutral in the underlying gravelly or sandy material.

NaA—Nenana silt loam, nearly level (0 to 3 percent slopes). This soil is on nearly level outwash plains. It has the profile described as typical for the series. Permeability is moderate in the silty material and very rapid in the underlying sandy material. Runoff is slow. The hazard of water erosion is slight.

Included with this soil in mapping are small tracts of Donnelly, Tanana, and Volkmar soils.

If cleared, this soil is suitable for frost-hardy vegetables, small grains, and grasses. Management group 9 (IIIs-1).

NaB—Nenana silt loam, gently sloping (3 to 12 percent slopes). This soil has been mapped in only a few areas adjoining bluffs and along the south boundary of the survey area. Permeability is moderate in the silty material and very rapid in the underlying sandy material. Runoff is medium. The hazard of erosion is slight to moderate.

Included with this soil in mapping are small areas of Donnelly and Tanana soils.

If cleared, this soil is suitable for frost-hardy vegetables, small grains, and grasses. Management group 8 (IIIe-4).

NeA—Nenana silt loam, sandy substratum, nearly level (0 to 3 percent slopes). This soil is on low dunes in narrow strips on the flood plain of the Nenana River. It has a profile similar to the one described as typical for the series, except it has a fine sand substratum. Permeability is moderate in the silty material and rapid in the underlying fine sand. Runoff is slow. The hazard of soil blowing is severe if there is no vegetative cover. The hazard of water erosion is slight.

Included with this soil in mapping are small areas of Goldstream, Salchaket, and Tanana soils.

If cleared, the soil is suitable for frost-hardy vegetables, small grains, and grasses. Management group 7 (IIIe-3).

Neb—Nenana silt loam, sandy substratum, gently sloping (3 to 7 percent slopes). This soil is on stabilized dunes on the flood plain of the Nenana River. It has a profile similar to the one described as typical for the series, except it has a fine sand substratum. Permeability is moderate in the silty material and rapid in the underlying fine sand. Runoff is medium. The hazard of soil blowing is severe where the vegetation has been removed. The hazard of water erosion is moderate.

Included with this soil in mapping are small areas of Goldstream and Tanana soils.

This soil is suitable for frost-hardy vegetables, small grains, and grasses. Management group 7 (IIIe-3).

Salchaket Series

The Salchaket series consists of deep, well-drained, nearly level to gently sloping soils that formed in sandy and silty alluvial deposits. They are mainly on natural levees adjacent to rivers and streams. The vegetation includes paper birch, cottonwood (balsam poplar), and white spruce.

Elevation is 350 to 600 feet. Average annual air temperature is 26° F, and average annual precipitation is 11 inches. The frost-free period is 85 to 100 days.

In a typical profile a dark reddish-brown mat of forest litter about 2 inches thick overlies a 6-inch layer of dark grayish-brown very fine sandy loam that has many dark-brown mottles. This is underlain by stratified dark grayish brown very fine sandy loam and fine sand that extends to a depth of about 25 inches. Below this is gray fine sand.

Salchaket soils generally are near Bradway, Goldstream, and Tanana soils. In the southern part of the Area, Salchaket soils also are near Donnelly and Nenana soils. Salchaket soils are used for frost-hardy vegetables, grains, and pasture.

Typical profile of Salchaket very fine sandy loam, NE¼NW¼ sec. 2, T. 4 S., R. 8 W., Fairbanks Meridian:

O1—2 inches to 0, dark reddish-brown (5YR 2/2) forest litter; admixture of silt; many roots; neutral; abrupt, smooth boundary.

C1—0 to 6 inches, dark grayish-brown (10YR 4/2) very fine sandy loam; many, coarse, distinct, dark-brown (10YR 3/3) mottles; layers and pockets of dark, partly decomposed organic matter; weak, fine, granular structure; very friable; common roots; neutral; clear, smooth boundary.

C2—6 to 25 inches, stratified dark grayish-brown (10YR 4/2) very fine sandy loam and dark grayish-brown (2.5Y 4/2) fine sand; sand strata are ½ to 1½ inches thick. making up about 20 percent of the volume of the horizon; few lenses of organic matter; very fine sandy loam is massive, fine sand is single grain; very fine sandy loam is very friable, fine sand is loose; common to few roots; neutral; abrupt, smooth boundary.

C3—25 to 42 inches, gray (10YR 5/1) fine sand; single grain; loose; few roots; neutral.

Reaction is commonly neutral throughout the profile, but in places it is slightly acid or medium acid in the upper horizons. The strata in the upper part of the C horizon vary greatly in thickness and range in texture from silt loam to sands. In most places, the C horizon is gravelly at a depth of 40 to 72 inches.

Sc—Salchaket very fine sandy loam. This soil is on natural levees adjacent to rivers and streams. Permeability is moderate. Runoff is slow. The hazard of water erosion is slight except on streambanks.

Included with this soil in mapping are small areas of Goldstream, Tanana, and Bradway soils in old stream channels. In places, Donnelly soils make up about 40 percent of the mapped area. Also included are small tracts of Nenana soils.

Trees generally grow to commercial size, except in areas where they have been repeatedly destroyed by fire. The existence of old stream channels in areas of these soils and adjacent poorly drained soils reduces the potential fire hazard. Where the soil is cleared, crops of frost-hardy vegetables, potatoes, perennial grasses, barley, and oats can be grown. Management group 1 (IIc-1).

Saulich Series

The Saulich series consists of poorly drained, nearly level to steep silty soils that formed in moderately deep to deep deposits of loess that overlies schist. These soils are generally on north-facing foot slopes of hills or on other foot slopes shaded by high hills. The vegetation includes black spruce, scattered clumps of willow and alder, low brush, and mosses.

Elevation ranges from 400 to 800 feet. Average annual temperature is 26° F, and average annual precipitation is 11 inches. The frost-free period is about 85 to 100 days.

In a typical profile a dark reddish-brown and black mat of peat and roots about 15 inches thick overlies frozen, dark-gray silt loam that contains streaks of organic matter.

Saulich soils generally are near Ester, Fairbanks, Goldstream, and Minto soils. The vegetation is a forest of black spruce in most places but commercial forests or cultivated crops can be grown in areas that can be drained.

Typical profile of Saulich silt loam, moderately sloping, SE¼NE¼ sec. 28, T. 2 S., R. 5 W., Fairbanks Meridian:

O11—15 inches to 9, dark reddish-brown (5YR 3/3) sphagnum moss peat, light reddish brown (5YR 6/3) when pressed; 100 percent fiber after rubbing; many roots; very strongly acid; clear, smooth boundary.

O12—9 inches to 4, black (N 2.5/0) moss and sedge peat; 100 percent fiber after rubbing; many roots; strongly acid; clear, smooth boundary.

O2—4 inches to 0, black (N 2.5/0) peat, black (10YR 2/1) when pressed; 70 percent fiber, 30 percent after rubbing; common roots; strongly acid; lower half of horizon is frozen; clear, smooth boundary.

C1f—0 to 6 inches, dark-gray (5Y 4/1) silt loam: streaks of organic matter; frozen with clear ice lenses; no roots; neutral.

The mantle of silt loam is about 30 inches to many feet thick over shattered schist. Permafrost is generally at a depth of 12 to 20 inches below the surface, but is deeper where the thick moss mat has been burned. Reaction is generally very strongly acid in the organic mat to medium acid or neutral in the C horizon.

SuA—Saulich silt loam, nearly level (0 to 3 percent slopes). This soil is in a few widely scattered areas adjacent to valley bottoms. Permeability is moderate above permafrost. Runoff is very slow. The hazard of water erosion is slight.

Included with this soil in mapping are a few small tracts of Fairbanks and Minto soils.

The native vegetation on this soil is useful mostly as wildlife habitat. Management group 14 (IVw-1).

SuB—Saulich silt loam, gently sloping (3 to 7 percent slopes). This soil is on north-facing foot slopes of hills and ridges. Permeability is moderate above permafrost. Runoff is slow. The hazard of water erosion is slight to moderate.

Included with this soil in mapping are small areas of Ester, Goldstream, Minto, and Steese soils. Also included are small tracts of moderately sloping Saulich soils.

Where cleared of moss and artificially drained, this soil may support a paper birch forest and is suitable for grass crops and some frost-hardy vegetables. Management group 15 (IVw-2).

SuC—Saulich silt loam, moderately sloping (7 to 12 percent slopes). This soil is on north-facing foot slopes of hills and ridges. It has the profile described as typical for the series. Permeability is moderate above permafrost. Runoff is medium. The hazard of water erosion is moderate.

Included with this soil in mapping are small areas of Ester and Goldstream soils and a few areas of gently sloping and strongly sloping Saulich soils.

Removal of the moss cover and artificial drainage could create conditions suitable for a paper birch forest or grass crops. Management group 15 (IVw-2).

SuD—Saulich silt loam, strongly sloping (12 to 20 percent slopes). This soil is on north-facing foot slopes of high hills and ridges. Permeability is moderate above permafrost. If the vegetation is removed, runoff is rapid and the hazard of water erosion is severe.

Included with this soil in mapping are small tracts of Ester, Goldstream, and Minto soils.

If the moss cover were not present, the soil could support a forest of paper birch and be suitable for pasture. Management group 17 (VIw-1).

SuE—Saulich silt loam, moderately steep (20 to 30 percent slopes). This soil is on a few long, north-facing slopes of hills. It has a profile similar to the one described as typical for the series, except the depth to shattered schist is generally more than 4 feet. Permeability is moderate above permafrost. If the soil has been cleared, runoff is rapid, and the hazard of water erosion is very severe.

Included with this soil in mapping are patches of Minto soils and small areas of less steep Saulich soils.

If the moss cover were not present, this soil could support stands of paper birch. The natural vegetation is useful only as wildlife habitat. Management group 19 (VIIw-1).

SuF—Saulich silt loam, steep (30 to 45 percent slopes). Only one area of this soil has been mapped, near Bonanza Creek. Permeability is moderate above permafrost.

The soil could probably support a stand of paper birch if it were cleared and the mossy surface layer removed, but the hazard of water erosion would be very severe. The soil is not suitable for crops. Management group 19 (VIIw-1).

Steese Series

The Steese series consists of well-drained, gently sloping to steep soils that formed in silty loess 20 to 40 inches thick over very channery silt loam. These soils commonly occupy middle slopes of hillsides and some ridgetops. The vegetation is a forest of paper birch, quaking aspen, and white spruce.

Elevation generally ranges from 800 to 1,600 feet. Average annual air temperature is 26° F, and average annual precipitation is 11 inches. The frost-free period is 85 to 100 days.

In a typical profile a dark reddish-brown mat of decomposing forest litter and roots about 2 inches thick overlies a mineral surface layer of very dark grayish-brown silt loam about 3 inches thick. The subsurface layer is dark grayish-brown silt about 3 inches thick. The subsoil is dark-brown silt that contains thin bands and pockets of fine silt loam. The substratum, below a depth of 21 inches, is grayish-brown silt about 6 inches thick over grayish-brown very channery silt loam.

Steese soils generally are near Ester, Fairbanks, and Gilmore soils, but in places they are near Gold-

stream, Minto, and Saulich soils. Steese soils support a forest of paper birch and white spruce that is of commercial size except in recently burned areas. If cleared, these soils are suitable for frost-hardy vegetables, potatoes, small grains, hay, and pasture.

Typical profile of Steese silt loam, moderately sloping, NE¼NE¼ sec. 30, T. 2 S., R. 5 W., Fairbanks Meridian:

O1—2 inches to 0, dark reddish-brown (5YR 2/2) forest litter; many roots; mycelia at base of horizon; charcoal fragments; slightly acid; abrupt, smooth boundary.

A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, very fine, granular structure; very friable; many roots; strongly acid; abrupt, wavy boundary.

A2—3 to 6 inches, dark grayish-brown (10YR 4/2) silt; many dark-brown (10YR 4/3) patches and streaks; weak, very thin, platy structure; very friable; many roots; medium acid; abrupt, wavy boundary.

B2—6 to 21 inches, dark-brown (10YR 4/3) silt; contains thin, nearly horizontal bands and pockets of dark-brown (10YR 3/3) fine silt loam; weak, very thin, platy structure; very friable; common roots; charcoal fragments; medium acid; abrupt, wavy boundary.

C1—21 to 27 inches, grayish-brown (10YR 5/2) silt; many horizontal, yellowish-brown (10YR 5/4) streaks; weak, very thin, platy structure; very friable; few roots; medium acid; abrupt, wavy boundary.

IIC2—27 to 36 inches, grayish-brown (2.5Y 5/2) very channery silt loam; massive; no roots; fragments of schist and quartz make up 60 percent of the soil, by volume; slightly acid.

The silty material is 20 to 40 inches thick over very channery silt loam. Reaction ranges from strongly acid to medium acid in the A and B horizons and slightly acid to neutral in the C horizon. Unweathered mica schist is below a depth of 48 inches.

SvB—Steese silt loam, gently sloping (3 to 7 percent slopes). This soil is in a few areas of ridges. Permeability is moderate. Runoff is slight to medium. The hazard of water erosion is moderate.

Included with this soil in mapping are small areas of Fairbanks and Gilmore soils and steeper Steese soils.

Paper birch, quaking aspen, or white spruce can be grown on this soil for commercial use. If the soil is cleared, frost-hardy vegetables, potatoes, perennial grasses, barley, and oats can be grown. Management group 3 (IIe-1).

SvC—Steese silt loam, moderately sloping (7 to 12 percent slopes). This soil is on ridges. It has the profile described as typical for the series. Permeability is moderate. Runoff is medium. The hazard of water erosion is moderate.

Included with this soil in mapping are small tracts of Fairbanks and Gilmore soils.

Paper birch, quaking aspen, or white spruce can be grown on this soil for commercial use. If the soil is cleared, frost-hardy vegetables, potatoes, perennial grasses, barley, and oats can be grown. Management group 5 (IIIe-1).

SvD—Steese silt loam, strongly sloping (12 to 20 percent slopes). This soil is on middle slopes of high hills and on a few broad, low ridges. Permeability is moderate. Runoff is medium to rapid. The hazard of water erosion is severe.

Included with this soil in mapping are a few small tracts of Fairbanks soils and steeper Steese soils.

Paper birch, quaking aspen, and white spruce can be grown on this soil for commercial use. If the soil is cleared, perennial grasses for hay and pasture can be grown safely, but other crops can be grown only if extreme precautions against erosion are taken. Management group 11 (IVe-1).

SvE—Steese silt loam, moderately steep (20 to 30 percent slopes). This soil commonly is on intermediate slopes of high hills. Permeability is moderate. Runoff is rapid. The hazard of water erosion is severe.

Included with this soil in mapping are small areas of Ester, Fairbanks, Gilmore, and, in places, Minto and Saulich soils.

Paper birch, quaking aspen, and white spruce can be grown on this soil for commercial use. The soil may also be used for perennial grasses. Management group 16 (VIe-1).

SvF—Steese silt loam, steep (30 to 45 percent slopes). This soil is on a few side slopes. Permeability is moderate. Runoff is very rapid if the soil is cleared. The hazard of water erosion is very severe.

This soil is used mainly as wildlife habitat. Management group 18 (VIIe-1).

Tanana Series

The Tanana series consists of nearly level, somewhat poorly drained soils that formed in silty and sandy sediment on flood plains. These soils are perennially frozen at a depth of 30 inches or more. This depth varies greatly, depending on the thickness of the organic mat on the surface and the frequency of flooding. The vegetation is black spruce, low-growing shrubs and sphagnum moss, or a young forest of willow, alder, and paper birch.

Elevation ranges from 350 to 1,000 feet. Average annual air temperature is about 26° F, and average annual precipitation is 11 inches. The frost-free period ranges from 85 to 100 days.

In a typical profile a black mat of partially decomposed forest litter about 3 inches thick overlies a layer of dark-gray silt loam mottled with dark brown and dark olive gray. This layer contains nearly horizontal, black organic streaks. It extends to a depth of 43 inches. The substratum is dark-gray fine sand.

Tanana soils generally are near Lemeta, Minto, and Salchaket soils and, in places, Goldstream and Nenana soils. The native vegetation on Tanana soils is mainly useful as wildlife habitat. If the organic mat is removed and artificial drainage is provided where necessary, these soils can produce stands of paper birch and white spruce, and they can be used for frost-hardy vegetables, potatoes, perennial grasses, barley, and oats.

Typical profile of Tanana silt loam, SE¼SE¼ sec. 34, T. 3 S., R. 8 W., Fairbanks Meridian:

O1—3 inches to 0, black (5YR 2/1), partially decomposed forest litter; about ½ inch of fresh, flood-deposited silty material near surface; many roots; slightly acid; abrupt, smooth boundary.

B21—0 to 25 inches, dark-gray (10YR 4/1) silt loam; many, medium, distinct, dark-brown (10YR 4/3) mottles; nearly horizontal streaks of black (10YR 2/1) organic matter, roughly ½ inch thick; weak, very thin, platy structure; very friable; few roots; neutral; gradual boundary.

B22—25 to 43 inches, dark-gray (5Y 4/1) silt loam; common, coarse, distinct, dark olive-gray (5Y 3/2) mottles; thin sandy lenses and thin organic layers; weak, thin, platy structure; friable; no roots; neutral; clear, wavy boundary.

IIC—43 to 76 inches, dark-gray (5Y 4/1) fine sand; single grain; loose; no roots; neutral; frozen at a depth of 76 inches.

The soil is dominantly silt loam, but thin lenses of fine sandy loam and fine sand are in the C horizon. Reaction ranges from medium acid to mildly alkaline. Permafrost is at a depth of 2 to 7 feet.

Ta—Tanana silt loam. This is the only Tanana soil mapped in the Area. Permeability is moderate. Runoff is slow. The hazard of water erosion is slight. This soil is on nearly level flood plains together with the Goldstream, Lemeta, Minto, Nenana, and Salchaket soils. Small areas of each of these soils are included with the Tanana soils.

If the organic mat is removed and artificial drainage is provided where necessary, this soil can produce stands of paper birch and white spruce, frost-hardy vegetables, potatoes, perennial grasses, barley, and oats. Management group 10 (IIIw-1).

Volkmar Series

The Volkmar series consists of nearly level, moderately well drained soils that formed in silty loess that is moderately deep over very gravelly coarse sand. The vegetation is generally a forest of black spruce, but in places, paper birch and white spruce are dominant.

Elevation ranges from 600 to 900 feet. Average annual air temperature is about 26° F, and average annual precipitation is 11 inches. The frost-free period ranges from 85 to 100 days.

In a typical profile a thin, black layer of forest litter overlies a surface layer of mottled, dark grayish-brown silt loam 2 inches thick. The subsoil is dark grayish-brown silt loam, 10 inches thick, that is highly mottled. The substratum is dark grayish-brown and olive-brown silt loam and gravelly silt loam to a depth of 35 inches. Below this it is very gravelly coarse sand.

Volkmar soils are near Donnelly and Nenana soils in the southwestern part of the survey area.

Typical profile of Volkmar silt loam, SW¼SW¼ sec. 5, T. 8 S., R. 8 W., Fairbanks Meridian:

O1—2½ inches to 0, black (10YR 2/1) forest litter; admixture of silt; many roots; very strongly acid; abrupt, smooth boundary.

A1—0 to 2 inches, dark grayish-brown (10YR 4/2) silt loam; common, medium, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, thin, platy structure parting to weak, fine, granular; friable; many roots; medium acid; abrupt, wavy boundary.

B2—2 to 12 inches, dark grayish-brown (2.5Y 4/2) silt loam; many, medium, distinct, olive-brown (2.5Y 4/4) mottles; weak, very thin, platy structure; friable; common roots; many fine vesicles; slightly acid; gradual boundary.

C1—12 to 27 inches, dark grayish-brown (2.5Y 4/2) silt loam; few irregular, dark-brown (10YR 4/3) streaks; moderate, thin, platy structure; friable; common to few roots; few fine pebbles; slightly acid; gradual boundary.

C2—27 to 35 inches, olive-brown (2.5Y 4/4) gravelly silt loam; moderate, medium, platy structure; friable; no roots; neutral; abrupt, wavy boundary.

IIC3—35 to 40 inches, very gravelly coarse sand; color varies with individual grains; single grain; loose; no roots; neutral.

The silty loess mantle ranges from 20 to 40 inches in thickness over the very gravelly material.

Vk—Volkmar silt loam. This is the only Volkmar soil mapped in the Area. It is on outwash plains and terraces along the Nenana River. Permeability is moderate in the silty material and rapid in the underlying gravelly coarse sand. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Nenana and Donnelly soils.

Forests on this soil are better suited to wildlife habitat than to other uses. If cleared, the soil produces barley, oats, perennial grasses, frost-hardy vegetables, and potatoes. Management group 9 (IIIs-1).

Use and Management of the Soils

This section discusses land clearing, crops and pasture, fertilizer, needs, and estimated yields of principal crops. The system of capability classification used by the Soil Conservation Service is described, and suggested management by groups of soils, or capability units, is given.

Land Clearing

The well drained and moderately well drained soils can be cleared at any time of the year after the merchantable timber has been harvested, but clearing is most efficient when the soils are not frozen. Trees, shrubs, and large roots left after logging can be pushed over and windrowed with a bulldozer equipped with a scarifier blade. In areas of sloping soils, the windrows should be diagonal to the slope in order to keep runoff from ponding on the upper sides and, at the same time, to control runoff from the newly cleared field. Natural drainageways should not be blocked by the windrows. When trees, shrubs, and roots in the windrows are dry, generally about a year after clearing, they should be burned. Several burnings generally are necessary to completely destroy the windrows.

When the soil is frozen, the trees can be sheared by a bulldozer and piled in windrows without disturbing the soil. Later in spring or in summer, the stumps and large roots can be moved to the windrows with a scarifier blade fitted to the bulldozer. When clearing the land, it is important to leave as much of the forest litter on the soil as possible so that it can be mixed with the mineral soil. This organic matter is effective in maintaining good tilth and promoting rapid infiltration of water.

Small stumps and roots can be disposed of with a large breaking plow or heavy disk. These materials decompose very slowly, however, and larger pieces may interfere with cultivation for a long time.

The somewhat poorly drained and poorly drained soils of the Area are often underlain with permafrost and covered with brush and moss or sedge tussocks. This material can most easily be removed when the ground is frozen with a bulldozer equipped with a shear blade. The depth to permafrost will gradually increase

as a result of disturbance of its insulating moss or sedge tussocks. In some soils, excess moisture perched above the permafrost table must be removed by drainage ditches before crops can be grown.

In areas where soil blowing is a hazard to cultivated fields, windbreaks of adequate width and spacing are essential to help control soil blowing and drifting.

Crops and Pasture

Most soils of the Goldstream-Nenana Area are silt loams. Cultivated crops can be grown on about 33 percent of the acreage in the survey area, but only a few areas of small total acreage have ever been used for this purpose. The principal crops include frost-hardy vegetables, potatoes, small grains, and legumes and grasses grown for hay and pasture. Poorly drained soils and steep soils are extensive in the Area. They generally are not suited to cultivated crops, but they can be used for pasture in some places.

Fertilization Requirements

Good growth of crops in the Area depends largely on whether the soils are adequately fertilized. Large amounts of fertilizer that contains nitrogen, phosphate, and potash are needed on all of the soils. Newly cleared soils need large quantities of nitrogen, because much of this element is used by bacteria to decompose the native organic material.

On the basis of experience and research, the Institute of Agricultural Sciences (*8*) periodically publishes minimum fertilization application rates. These rates, provided as a guide for determining needs, are general suggestions and are subject to change.

Under continued cultivation, the structure of the soils in the survey area tends to break down. Adding manure or other organic material helps maintain tilth.

Estimated Yields

Estimated average yields per acre of principal crops grown on soils in the Area are given in table 2. These estimates are averages expected over several years under improved management.

Practices and conditions under improved management include fertilizer applied at rates determined by periodic soil tests, barnyard manure and crop residue used to help maintain sufficient organic matter in the soil, and conservation practices applied where needed to control soil blowing and water erosion.

Because farming is practically nonexistent in the Goldstream-Nenana Area, sufficient data are not available to establish quantitative differences in the productivity of the soils. A few crops have been grown on nearly level to gently sloping, moderately deep to deep, moderately well drained and well drained soils. It is likely that on strongly sloping, very shallow, or poorly drained soils, some of the crops listed in table 2 cannot be grown, and yields of most crops will be lower than those estimated in table 2.

TABLE 2.—*Estimated average yields per acre of principal crops under an improved level of management*

Crop	Improved management
Potatoes ... tons	10–12
Barley ... bushels	50–55
Oats ... bushels	60–70
Bromegrass hay ... tons	2½–3
Bromegrass for silage ... tons	7–9
Oats-pea for silage ... tons	8–10

In most years, the moisture level in midsummer in the well-drained soils generally is lower than the level required for optimum plant growth. Preliminary investigations indicate that yields can be increased by using sprinklers for irrigation, but data on the effect and economic feasibility of extensive irrigation systems are not available.

Abnormal crop seasons, past management, and the possible effect of irrigation are not considered in the yield estimates given in table 2.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to cranberries, horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when they are used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for commercial forestry or for engineering.

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils (none in this Area) have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils (none in this Area) are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VI soils have severe limitations that make them generally unsuited to cultivation and that limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture, range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and that restrict their use to recreation, wildlife habitat, or water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage) ; *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

CAPABILITY UNITS are soil groups within the subclasses. In this survey they are called management groups. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–1 or IIIe–4. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the preceding paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass. In this survey the capability unit numbers are in parentheses following the management group numbers.

Management Groups

In the pages that follow, management groups of the Goldstream-Nenana Area are described, and suggestions are given for the use, management, and conservation of the soils in each group. The management group in which each soil has been placed can be found in the "Guide to Mapping Units" at the back of this survey.

No specific recommendations are made as to the amounts and kinds of fertilizer needed, the most suitable crop varieties, or the best seeding rates, because these elements change with new developments in farming. Current information and recommendations are available from the Extension Service agent in Fairbanks and from the University of Alaska, Institute of Agricultural Sciences.

MANAGEMENT GROUP 1 (IIc–1)

This group consists of nearly level to gently sloping, deep, well-drained silty soils on uplands and stratified very fine sandy loams and fine sands on flood plains.

Permeability and available water capacity are moderate in the soils of this group. Runoff is slow. The hazard of water erosion is slight. The hazard of soil blowing is moderate in areas subject to high winds.

Most areas of these soils are wooded. In cleared areas the main crops suitable for planting are potatoes, hardy vegetables, perennial grasses, oats, and barley.

Organic matter is needed to help keep soils of this group in good tilth and to promote efficient use of moisture and plant nutrients. Return of crop residue to the soil and regular additions of manure help to maintain the content of organic matter. Leaving a strip of the natural vegetation at right angles to the prevailing wind in areas cleared for cultivation and including alternate strips of grasses in the cropping system help to control soil blowing. Most crops on these soils respond well to fertilizer that contains nitrogen, phosphorus, and potassium. In most years, yields can be increased by irrigation.

MANAGEMENT GROUP 2 (IIc–2)

Only Minto silt loam, nearly level, is in this group. This moderately well drained soil is mainly on low knolls in broad interior valleys. It is underlain by large, discontinuous masses of ice that melt in cleared areas.

Permeability and available water capacity are moderate. Runoff is slow, and the hazard of water erosion is slight.

Most of the acreage of this soil has a natural vegetative cover of black spruce, low brush, moss, and lichens.

This soil is among the most productive in the Area, mainly because it is not likely to be droughty in dry summers. All crops adapted to the Area can be grown. Most crops respond well to fertilizer when applied according to needs determined by soil tests. Additions of organic matter are needed periodically to help maintain good tilth.

After clearing, fields may become badly pitted as a result of subsidence caused by melting of ice below the surface. Land leveling is generally practical in restoring fields to a useful condition.

MANAGEMENT GROUP 3 (IIe–1)

This group consists of gently sloping, medium-textured, well-drained soils on ridgetops and foot slopes. These soils formed in deep and moderately deep loess.

Permeability and available water capacity are moderate. Runoff is medium, and the hazard of water erosion is slight to moderate.

Most areas of these soils are wooded. If the soils are cleared, all crops adapted to the Area can be grown, but periodic additions of organic matter are needed to help keep the soil in good tilth. Contour stripcropping

and grassed waterways help to control water erosion. Crops on these soils respond well to fertilizer that contains nitrogen, phosphorus, and potassium. In most years crops respond to supplemental irrigation provided mainly by sprinkler systems.

MANAGEMENT GROUP 4 (IIe-2)

Only Minto silt loam, gently sloping, is in this group. This soil is deep, medium textured, and moderately well drained. It is underlain by discontinuous masses of ice that melt when the soil is cleared.

Permeability and available water capacity are moderate. Runoff is slow to medium and the hazard of erosion is slight to moderate.

Most areas of these soils support either a paper birch-white spruce forest or a black spruce forest. If the soil is cleared, all crops common to the Area can be grown.

The soil is susceptible to uneven settling and pitting after clearing as a result of melting ice. Most pitted areas can be reclaimed by land leveling. Contour cultivation and stripcropping reduce water erosion on this soil. Returning crop residue to the soil and adding manure help keep the soil in good tilth. Crops respond well to fertilizer that contains nitrogen, phosphorus, and potassium. In most years this soil remains moist throughout the growing season.

MANAGEMENT GROUP 5 (IIIe-1)

This group consists of medium-textured, well-drained, deep and moderately deep, moderately sloping soils that formed in loess. They are on uplands.

Permeability and available water capacity are moderate. Runoff is medium, and the hazard of water erosion is moderate.

Most areas of these soils are wooded. If the soils are cleared, all crops adapted to the Area can be grown. Stripcropping on the contour, maintaining diversion ditches and natural waterways in sod, and including grasses in the cropping system help control water erosion. Returning crop residue and adding manure regularly to these soils helps keep the soil in good tilth. Crops respond well to fertilizer that contains nitrogen, phosphorous, and potassium. In most years crops respond well to irrigation. The best adapted system is sprinklers.

MANAGEMENT GROUP 6 (IIIe-2)

Only Minto silt loam, moderately sloping, is in this group. This deep, moderately well drained soil is underlain by large, discontinuous masses of ice that melt when the soil is cleared of vegetation.

Permeability and available water capacity are moderate. Runoff is medium, and the hazard of water erosion is moderate.

Most of the acreage of this soil is wooded. In cleared areas, potatoes, frost-hardy vegetables, perennial grasses, oats, and barley can be grown.

Stripcropping on the contour and keeping alternate strips and waterways in grass help control water erosion in cultivated areas. In cleared areas, pits and hummocks may form because of melting ice blocks below the surface. Most pitted areas can be reclaimed by land leveling.

Returning plant residue and manure to the soil regularly helps keep the soil in good tilth and promotes efficient use of moisture and plant nutrients. Crops respond well to fertilizer that contains nitrogen, phosphorus, and potassium. Supplemental irrigation is not generally needed.

MANAGEMENT GROUP 7 (IIIe-3)

This group consists of well-drained, medium-textured, nearly level to gently sloping soils that are shallow to moderately deep over a fine sand substratum.

Permeability is moderate in the upper part of the soil and rapid in the substratum. Available water capacity is low. Runoff is slow to medium, and the hazard of water erosion is slight to moderate. The hazard of soil blowing is severe where the vegetation has been removed.

Most areas are wooded. In cleared areas, crops common to the Area can be grown. Strips of trees, perpendicular to the direction of the prevailing winds and of adequate width and spacing, should be left to control soil blowing and drifting. Organic matter is needed to keep the soil in good tilth. Crops respond well to fertilizer that contains nitrogen, phosphorus, and potassium. In most years crops respond to supplemental irrigation.

MANAGEMENT GROUP 8 (IIIe-4)

This group consists of medium-textured, well-drained soils that are shallow over very gravelly or very channery material. These soils are gently sloping.

Permeability is moderate in the upper part of the soil and rapid or very rapid in the substratum. Available water capacity is low. Runoff is slow to medium, and the hazards of water erosion and soil blowing are slight to moderate.

Most areas are wooded. In cleared areas, most crops adapted to the Area can be grown. Contour cropping and strips of trees planted at right angles to the prevailing winds help control soil blowing. Organic matter is needed to keep the soil in good tilth. Crops respond well to fertilizer that contains nitrogen, phosphorus, and potassium. In most years crops respond well to irrigation.

MANAGEMENT GROUP 9 (IIIs-1)

This group consists of moderately well drained and well drained, medium-textured soils that are shallow and moderately deep over very gravelly coarse sand. These nearly level soils are on broad outwash plains.

Permeability is moderate in the upper part of the soil and rapid and very rapid in the underlying very gravelly coarse sand. Available water capacity is low to moderate. Runoff is slow. The hazard of water erosion is slight.

Most areas of these soils are wooded. Because of extensive fires in the past, the soils now support a young forest. In cleared areas, these soils are suitable for frost-hardy vegetables, small grains, and grasses.

Organic matter is needed to keep the soil in good tilth. Crops respond well to fertilizer that contains nitrogen, phosphorus, and potassium. In most years crops respond well to irrigation.

MANAGEMENT GROUP 10 (IIw-1)

Only Tanana silt loam is in this group. This is a somewhat poorly drained, medium-textured alluvial soil with permafrost. It is in nearly level areas on flood plains.

Permeability and available water capacity are moderate above the permafrost. Runoff is slow, and the hazard of water erosion is slight.

Most areas of the soil are wooded and underlain by permafrost at a depth of more than 30 inches. In cleared areas, the permafrost table recedes to a greater depth, and excess moisture drains downward into the soil. About a year is needed after clearing before the soil is dry enough to cultivate. In places shallow drainage ditches are needed to remove excess water in spring. All crops common to the Area can be grown. Early planting reduces the risk of crop damage by late-summer frosts. Plants respond well to fertilizer that contains nitrogen, phosphorus, and potassium.

MANAGEMENT GROUP 11 (IVe-1)

This group consists of well drained to moderately well drained, strongly sloping, medium-textured soils that formed in deep and moderately deep loess. These soils are on uplands.

Permeability and available water capacity are moderate. Runoff is medium to rapid, and the hazard of water erosion is severe.

Most areas of these soils are wooded. In cleared areas, grasses alone or grasses in contour strips with other crops help to control water erosion and prevent gullying and excessive soil loss. Crops on these soils respond well to fertilizer that contains nitrogen, phosphorus, and potassium.

MANAGEMENT GROUP 12 (IVe-2)

This group consists of gently sloping, excessively drained soils that are very shallow to very gravelly coarse sand, and moderately sloping and strongly sloping, well-drained soils that are shallow over very channery silt loam.

Permeability is moderate in the upper part of the soil and rapid to very rapid in the substratum. Available water capacity is low to very low. Runoff ranges from slow to rapid. The hazard of soil blowing and water erosion is moderate to severe.

In cleared areas, these soils have only limited potential for growing cultivated crops. Perennial grasses in most years and contour stripcropping when barley and oats are grown help to control water erosion and soil blowing. Returning crop residues to the soil, adding manure regularly, and including grasses in the cropping system help to keep these soils in good tilth and promote efficient use of moisture. Crops on these soils respond well to fertilizer that contains nitrogen, phosphorus, and potassium. In most years lack of moisture limits crop growth.

MANAGEMENT GROUP 13 (IVs-1)

Only Donnelly silt loam, nearly level, is in this group. This excessively drained silty soil is very shallow over very gravelly coarse sand.

Permeability is moderate in the surface layer and very rapid in the substratum. Available water capacity is very low. Runoff is very slow to slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate to severe.

If cleared, these soils are suitable only for grass. Leaving strips of trees between cleared areas helps control soil blowing. Returning crop residues to the soil and regularly adding manure help to keep these soils in good tilth and to promote efficient use of moisture and plant nutrients. Crops on these soils respond well to fertilizer that contains nitrogen, phosphorus, and potassium. In most years, lack of moisture is likely to limit production.

MANAGEMENT GROUP 14 (IVw-1)

This group consists of nearly level, poorly drained silty soils with permafrost at varying depths. In places the silty material is underlain by very gravelly sand or schist at a moderate depth.

Permeability is moderate in the unfrozen surface layer. Available water capacity is moderate in drained areas. Runoff is very slow, and the hazard of water erosion is slight.

Clearing these soils and removing the surface mat of organic matter lowers the permafrost table. Excess moisture can then be removed by drainage ditches. Even after clearing and draining, these soils tend to dry slowly in spring. This may delay spring planting and increase the risk of frost damage to crops in late summer. Grasses, small grains grown for forage, and vegetables that mature early are best suited to the soils. They respond well to fertilizer that contains nitrogen, phosphorus, and potassium. In many places, the native vegetation can be used for limited grazing.

MANAGEMENT GROUP 15 (IVw-2)

This group consists of poorly drained silty soils that are nearly level to gently sloping. Permafrost is at a shallow depth.

Permeability and available water capacity are moderate in drained areas. Runoff is very slow to medium, and the hazard of water erosion is slight to moderate.

Under the native vegetation, these soils are cold and wet throughout the growing season. In many places, the soils receive seepage water from surrounding areas. If these soils are cleared for cultivated crops, the surface mat must be removed to permit the permafrost table to recede to a greater depth. Drainage ditches can then be built to remove excess moisture. These soils are suitable for early-maturing vegetables and for perennial grasses, oats, and barley grown for forage. These crops respond well to fertilizer that contains nitrogen, phosphorus, and potassium. Avoiding tillage when the soil is wet, adding manure, and returning crop residues to the soils regularly help to maintain soil tilth.

MANAGEMENT GROUP 16 (VIe-1)

This management group consists of well-drained, moderately sloping silty soils that are very shallow to very channery silt loam, and well-drained, moderately steep silty soils that are shallow to deep to very channery silt loam.

Permeability is moderate in the silty material. Avail-

able water capacity is low to moderate. Runoff is medium to rapid, and the hazard of water erosion is moderate to severe.

The soils in this group are too steep to be cultivated. If cleared, they are suited only to perennial grasses for pasture. Topdressing with nitrogen fertilizer helps maintain a permanent cover of grass.

MANAGEMENT GROUP 17 (VIw-1)

Only Saulich silt loam, strongly sloping, is in this group. This poorly drained silty soil has permafrost at a shallow depth.

Permeability is moderate above permafrost. Runoff is rapid, and the hazard of water erosion is severe.

Removal of the thick moss mat on the surface of this soil lowers the permafrost table. Drainage ditches are needed to carry off seepage, which tends to keep the soil wet and cold, from higher areas. After clearing and drainage, this soil can be seeded to perennial grasses and used as pasture.

MANAGEMENT GROUP 18 (VIIe-1)

This group consists of moderately steep and steep, deep to very shallow, excessively drained to well-drained silty soils.

Runoff is medium to very rapid, and the hazard of water erosion is severe to very severe.

These soils are too steep and too susceptible to gully erosion to be cultivated. They are suitable mainly for wildlife habitat and watershed protection.

MANAGEMENT GROUP 19 (VIIw-1)

This group consists of poorly drained, medium-textured, strongly sloping to steep soils with permafrost at a shallow depth.

In severely burned or cleared areas, runoff is rapid, and the hazard of water erosion is severe to very severe. These soils remain wet and cold throughout the growing season. They are not suitable for cultivated crops or pasture. They are suitable mainly for wildlife habitat and watershed protection.

MANAGEMENT GROUP 20 (VIIw-2)

Only Lemeta peat is in this group. This very poorly drained soil has permafrost at a shallow depth.

Lemeta peat has no value for farming. It remains cold and wet throughout the growing season, and artificial drainage is not feasible. In places the soil supports vegetation that is suitable for light grazing. The peat has some commercial value.

MANAGEMENT GROUP 21 (VIIIs-1)

Only Mine tailings is in this group. This land type consists of piles of coarse gravel that may support stunted stands of alder, willow, and aspen that are used as wildlife habitat. The tailings are a source of fill material and may provide building sites. They are a possible source area of gravel for construction purposes.

Engineering Uses of the Soils

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, and pipelines; the foundations of buildings; facilities for storing water; structures for controlling erosion; drainage systems; and systems for disposing of sewage. Among the properties most important to the engineer are shear strength, compaction characteristics, soil drainage, permeability, shrink-swell characteristics, grain size, plasticity, and reaction. Also important are depth to seasonal high water table, flooding hazard, and relief. Such information is available in this section. Engineers can use it to—

1. Make studies that will aid in selecting and developing sites for industries, businesses, residences, and recreational areas.
2. Make estimates of the engineering properties of soils for use in the planning of systems for draining cropland and pasture, grassed waterways, farm ponds, irrigation systems, terraces and diversions, and other structures for conserving soil and water.
3. Make preliminary evaluations of soil conditions that will aid in selecting locations for highways, airports, pipelines, cables, and sewage disposal fields and in planning more detailed surveys of the soils at the selected locations.
4. Locate probable sources of sand, gravel, and other materials for use in construction.
5. Correlate the performance of engineering structures with the soil mapping units to develop information for general planning that will be useful in designing and maintaining new structures.
6. Determine the suitability of the soils for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that can be readily used by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

Used with the soil map to identify the soils, the engineering interpretations in this section are useful for many purposes. It should be emphasized, however, that these interpretations are not a substitute for the sampling and testing needed at a site chosen for a specific engineering work that involves heavy loads or at a site where excavations are to be deeper than the depths of the layers here reported. Nevertheless, by using this survey, an engineer can select and concentrate on those soils most important for this proposed kind of construction. In this manner he can reduce the number of soil samples taken for laboratory testing and complete an adequate soil investigation at minimum cost.

The soil mapping units shown on the maps in this survey may include small areas of a different soil material. These included soils may be as much as 2 acres in size. They are too small to be mapped separately and generally are not significant to the farming

TABLE 3.—*Engineering*

[Tests performed by Materials Testing Laboratory,

Soil name and location	Parent material	Laboratory number	Depth	Moisture-density [1]		Mechanical analysis [2]			
						Percentage passing sieve—			
				Maximum dry density	Optimum moisture	3-inch	2-inch	1½-inch	1-inch
			Inches	*Pounds per cubic foot*	*Percent*				
Fairbanks silt loam:									
NE¼NE¼ sec. 29, T. 2 S., R. 5 W. (Modal)	Loess.	730284	0–3	92	26	---	---	---	---
		730285	8–21	111	17	---	---	---	---
		730286	21–40	111	17	---	---	---	---
SE¼NW¼ sec. 12, T. 1 N., R. 3 W.	Loess.	730305	0–3	102	20	---	---	---	---
		730306	7–18	115	14	---	---	---	---
		730307	18–40	114	15	---	---	---	---
SW¼SW¼ sec. 16, T. 3 S., R. 7 W.	Loess.	730297	0–3	101	20	---	---	---	---
		730298	6–15	115	15	---	---	---	---
		730299	15–40	107	17	---	---	---	---
Gilmore silt loam:									
NW¼SW¼ sec. 1, T. 2 S., R. 4 W. (Modal)	Loess over schist.	730289	0–4	92	23	---	---	---	---
		730290	7–14	111	17	---	---	---	---
		730291	14–24	117	13	100	94	89	84
NW¼NE¼ sec. 2, T. 4 S., R. 8 W.	Loess over shattered schist.	730294	2–10	100	20	---	---	---	---
		730295	10–18	100	20	---	---	---	---
		730296	18–30	133	8	100	93	88	76
SW¼NW¼ sec. 34, T. 2 S., R. 6 W.	Loess over shattered schist.	730300	0–3	92	23	---	---	---	---
		730301	3–16	108	18	---	---	---	---
		730302	16–30	122	8	93	93	91	87
Goldstream silt loam:									
NE¼SE¼ sec. 24, T. 1 N., R. 3 W. (Modal)	Alluvium.	730303	0–10	107	18	---	---	---	---
		730304	10–28	108	17	---	---	---	---
NW¼SW¼ sec. 26, T. 2 S., R. 5 W.	Alluvium.	730287	0–3	52	62	---	---	---	---
		730288	3–12	102	19	---	---	---	---
NE¼SE¼ sec. 2, T. 5 S., R. 8 W.	Alluvium.	730292	0–5	77	36	---	---	---	---
		730293	5–16	106	17	---	---	---	---

[1] Based on ASTM Specification D–1557–70, Method C.

[2] Results by the procedure used may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service. In the Testing Laboratory procedure, the fine material is determined by the hydrometer method, and the various grain-sized fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is

in the area, but they may be important in engineering planning.

Information of value in planning engineering work is given throughout the text, particulary in the sections "Descriptions of the Soils" and "Formation and Classification of Soils."

Some of the terms in this publication have a special meaning to soil scientists and a different meaning to engineers. The Glossary defines many such terms as they are used in soil science.

Much of the information in this section is given in tables. Table 3 gives engineering test data, table 4 gives estimated soil properties significant to engineering, and table 5 gives engineering interpretations of the soils.

Engineering Classification Systems

Soil scientists of the United States Department of Agriculture (USDA) classify soils according to texture (*13*). In some ways this system of naming textural classes is comparable to the two systems most commonly used by engineers to classify soils; that is, the Unified system developed by the Department of Defense (*2*) and used by the Soil Conservation Service and other agencies, and the AASHTO system (*1*) adopted by the American Association of State Highway and Transportation Officials.

The Unified system is used to classify soils according to those properties that affect use as a construction material for purposes other than highway construction and maintenance and as a foundation material.

In the Unified system, soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content, and they are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic

test data

Soil Conservation Service, Portland, Oregon]

Mechanical analysis [2]—continued										Liquid limit	Plasticity index	Classification	
Percentage passing sieve—continued						Percentage smaller than—						AASHTO	Unified
¾-inch	⅜-inch	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
										Percent			
---	---	100	99	91	83	70	39	9	0	[3] NV	[4] NP	A-4 (8)	ML
---	---	---	100	98	94	76	40	10	3	NV	NP	A-4 (8)	ML
---	---	---	100	99	97	78	38	7	0	27	2	A-4 (8)	ML
---	---	100	99	96	93	77	43	14	9	NV	NP	A-4 (8)	ML
---	---	---	100	99	97	81	46	15	11	31	5	A-4 (8)	ML
---	---	---	100	99	97	78	38	11	6	NV	NP	A-4 (8)	ML
---	---	---	100	98	95	76	40	11	6	37	7	A-4 (8)	ML
---	---	---	100	99	98	85	55	20	17	34	9	A-4 (8)	ML
---	---	---	---	100	99	73	23	0	0	NV	NP	A-4 (8)	ML
---	---	100	99	93	85	70	39	11	6	42	9	A-5 (8)	ML
100	99	99	98	94	91	78	47	12	8	NV	NP	A-4 (8)	ML
81	74	69	65	58	54	48	35	9	2	31	3	A-4 (4)	ML
---	100	99	99	97	96	78	38	1	0	NV	NP	A-4 (8)	ML
---	---	---	100	99	96	74	31	0	0	NV	NP	A-4 (8)	ML
70	56	43	31	19	11	10	6	2	0	NV	NP	A-1-a (0)	GP-GM
100	99	98	97	80	70	58	34	8	2	46	12	A-7-5 (9)	ML
---	---	100	98	90	81	68	40	10	0	NV	NP	A-4 (8)	ML
84	76	67	55	34	17	14	9	3	0	NV	NP	A-1-b (0)	SM
---	---	---	100	99	97	83	51	16	11	NV	NP	A-4 (8)	ML
---	---	---	100	99	96	79	43	14	10	31	3	A-4 (8)	ML
---	---	100	96	88	79	64	33	0	0	102	NP	A-5 (12)	OH
---	---	---	100	99	97	72	24	0	0	NV	NP	A-4 (8)	ML
---	---	---	100	97	93	82	54	20	12	66	17	A-7-5 (15)	MH
---	---	---	100	99	97	84	54	16	12	36	9	A-4 (8)	ML

excluded from calculations of grain-sized fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes of soil.

[3] No value.

[4] Nonplastic.

soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 3; the estimated classification, without group index numbers, is given in table 4 for all soils mapped in the survey area.

USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. "Sand," "silt," "clay," and some of the other terms used in the USDA textural classification are defined in the Glossary.

Engineering Test Data

Table 3 gives test data for samples obtained from three soil series that are extensive in the Goldstream-Nenana Area. Selected layers were tested by standard procedures in the Materials Testing Laboratory of the Soil Conservation Service in Portland, Oregon. The

TABLE 4.—*Estimated soil properties*

[The symbol > means more than;

Soil series and map symbols	Depth to— Bedrock	Depth to— Permafrost table in uncleared areas	Depth to— Seasonal high water table	Depth from surface of typical profile	Dominant USDA texture
	Feet	*Feet*	*Feet*	*Inches*	
Bradway: Br	(1)	2–4	[2] 0–2	0–36	Very fine sandy loam
Donnelly: DoA, DoB, DoF	(1)	(4)	(5)	0–4	Silt loam
				4–7	Gravelly silt loam
				7–18	Very gravelly coarse sand
Ester: EsD, EsE, EsF	>3½	<1	[2] 0–1	14–0	Peat
				0–4	Silt loam
				4–9	Very channery silt loam
Fairbanks: FaA, FaB, FaC, FaD, FaE, FaF.	(1)	(4)	(5)	0–3	Silt loam
				3–40	Silt
Gilmore: GmB, GmC, GmD, GmE, GmF, GrB, GrC, GrE, GrF.	>3½	(4)	(5)	0–4	Silt loam
				4–14	Silt
				14–24	Very channery silt loam
Goldstream: GtA, GtB	(1)	1–3	[2] 0–½	10–0	Peat
				0–36	Silt loam
Goodpaster: GuA	(1)	>3½	0–½	9–0	Peat
				0–15	Silt loam
				15–25	Very gravelly coarse sand
Lemeta: Lp	(1)	1½–3	0–½	0–32	Peat
Mine tailings: Me	(1)	(4)	(5)	0–60	Gravel
Minto: MnA, MnB, MnC, MnD	(1)	>6	3–5	0–3	Silt loam
				3–40	Silt
Nenana:					
NaA, NaB	(1)	(4)	(5)	0–15	Silt loam
				15–20	Gravelly silt
				20–30	Very gravelly coarse sand
NeA, NeB	(1)	(4)	(5)	0–20	Silt loam
				20–30	Fine sand
Salchaket: Sc	(1)	(4)	(5)	0–6	Very fine sandy loam
				6–25	Very fine sandy loam
				25–42	Fine sand
Saulich: SuA, SuB, SuC, SuD, SuE, SuF.	2½–10	0–2	[2] 0–1½	15–0	Peat
				0–6	Silt loam
Steese: SvB, SvC, SvD, SvE, SvF	>3½	(4)	(5)	0–3	Silt loam
				3–27	Silt
				27–36	Very channery silt loam
Tanana: Ta	(1)	2–4	[2] 1½–2½	0–43	Silt loam
				43–76	Fine sand
Volkmar: Vk	(1)	(4)	3–5	0–27	Silt loam
				27–35	Gravelly silt loam
				35–40	Very gravelly coarse sand

[1] Bedrock not encountered to depth of observation, which generally is 5 feet.
[2] Perched above permafrost.
[3] Coarse fragments greater than 3 inches not considered in table.

significant to engineering

the symbol < means less than]

Classification		Percentage passing sieve—			Permeability	Available water capacity	Reaction
Unified	AASHTO	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 200 (0.074 mm)			
					Inches per hour	*Inches per inch of soil*	*pH*
ML	A-4	[3] 100	100	60–70	0.6–2.0	0.12–0.16	6.1–7.8
ML	A-4	95–100	95–100	80–90	0.6–2.0	0.18–0.23	5.1–6.0
ML or GM	A-4	[3] 60–80	55–70	40–60	2.0–6.0	0.12–0.18	5.6–6.0
GW or GP	A-1	[3] 30–50	20–40	0–5	>20.0	0.02–0.04	6.1–7.3
ML	A-4	100	100	------	2.0–6.0	>0.25	3.5–5.5
Pt	A-8	------	------	85–95	0.6–2.0	0.18–0.23	3.5–5.5
GM	A-2	[3] 40–50	30–40	35–45	0.6–2.0	0.06–0.08	5.1–6.0
ML	A-4	100	100	85–95	0.6–2.0	0.18–0.23	5.1–6.5
ML	A-4	100	100	90–100	0.6–2.0	0.18–0.23	5.5–7.3
ML	A-4	100	100	85–95	0.6–2.0	0.18–0.23	5.1–6.0
ML	A-4	100	100	90–100	0.6–2.0	0.18–0.23	5.6–6.0
GM or GP–GM	A-1 or A-2	[3] 25–45	20–40	10–35	6.0–20.0	0.06–0.08	6.1–7.3
Pt	A-8	------	-------	----	2.0–6.0	>0.25	4.0–5.6
ML	A-4	100	95–100	80–95	0.6–2.0	0.18–0.23	4.5–5.5
Pt	A-8	---	---	------	2.0–6.0	>0.25	5.6–6.5
ML	A-4	100	95–100	80–95	0.6–2.0	0.18–0.23	5.1–6.0
GW or GP	A-1	[3] 25–50	20–40	0–5	>20.0	0.02–0.04	5.1–6.0
Pt	A-8	-------	-------	------	2.0–6.0	>0.25	4.0–5.0
GP	A-1	[2] 20–40	15–30	0–5	>20.0	0.02–0.04	------
ML	A-4	100	100	85–95	0.6–2.0	0.18–0.23	5.1–5.5
ML	A-4	100	100	90–100	0.6–2.0	0.18–0.23	5.6–7.3
ML	A-4	100	100	85–95	0.6–2.0	0.18–0.23	5.6–6.0
GM	A-4	[3] 55–65	50–60	40–50	2.0–6.0	0.12–0.18	5.6–6.0
GW or GP	A-1	[3] 20–40	15–30	0–5	>20.0	0.02–0.04	6.1–7.3
ML	A-4	100	95–100	85–95	0.6–2.0	0.18–0.23	5.6–6.0
SM, SP-SM	A-2 or A-3	90–100	75–95	5–15	6.0–20.0	0.04–0.08	6.1–7.3
ML	A-4	100	95–100	55–70	0.6–2.0	0.18–0.23	5.6–7.3
ML	A-4	100	95–100	55–70	0.6–2.0	0.14–0.18	6.6–7.3
SM	A-2	100	95–100	10–20	6.0–20.0	0.04–0.08	6.6–7.3
Pt	A-8	------	-------	-----	2.0–6.0	>0.25	4.5–5.5
ML	A-4	100	100	85–95	0.6–2.0	0.18–0.23	5.6–7.3
ML	A-4	100	100	85–95	0.2–2.0	0.18–0.23	5.1–6.1
ML	A-4	100	100	90–100	0.2–2.0	0.18–0.23	5.1–6.0
GM or GM–GP	A-1 or A-2	[3] 25–45	20–40	10–30	6.0–20.0	0.06–0.08	6.1–7.3
ML	A-4	100	100	95–100	0.2–2.0	0.18–0.23	6.1–7.3
SM, SP-SM	A-2 or A-3	90–100	75–95	5–15	6.0–20.0	0.04–0.08	6.6–7.8
ML	A-4	100	95–100	85–95	0.2–2.0	0.18–0.23	5.6–6.5
ML or GM	A-4	[3] 60–80	55–70	40–60	2.0–6.0	0.12–0.18	6.1–7.3
GW	A-1	[3] 20–40	15–30	0–5	6.0–20.0	0.02–0.04	6.6–7.3

[4] None.
[5] Water table not observed to depth of observation, which generally is 5 feet, or to bedrock, whichever is less.

TABLE 5.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Susceptibility to frost action
	Topsoil	Sand	Gravel	Road fill	
Bradway: Br	Poor: high water table; permafrost.	Unsuited	Unsuited	Poor: high water table; permafrost.	High: permafrost
Donnelly: DoA, DoB, DoF.	Poor: shallow to gravel.	Good: gravelly	Good: some stones and cobbles.	Good	Low
Ester: EsD, EsE, EsF.	Poor: high water table; permafrost.	Unsuited	Unsuited	Poor: high water table; permafrost.	High: permafrost
Fairbanks: FaA, FaB, FaC, FaD, FaE, FaF.	Good where slope is 0 to 7 percent, fair where 7 to 12, poor where 12 to 45.	Unsuited	Unsuited	Poor: high frost action.	High: silty
Gilmore: GmB, GmC, GmD, GmE, GmF.	Fair where slope is 3 to 12 percent, shallow; poor where 12 to 45.	Unsuited	Unsuited	Fair where slope is 3 to 20 percent, poor where 20 to 45.	High: silty
GrB, GrC, GrE, GrF.	Poor: very shallow.	Unsuited	Unsuited	Fair where slope is 3 to 20 percent, poor where 20 to 45.	Moderate: silty
Goldstream: GtA, GtB.	Poor: high water table; permafrost.	Unsuited	Unsuited	Poor: high water table; permafrost.	High: permafrost
Goodpaster: GuA	Poor: high water table.	Poor: high water table.	Poor: high water table.	Poor: high water table; permafrost.	High: high water table; permafrost.
Lemeta: Lp	Poor: peat, permafrost.	Unsuited	Unsuited	Unsuited: peat	High: permafrost
Mine tailings: Me	Unsuited	Unsuited	Good	Good	Low
Minto: MnA, MnB, MnC, MnD.	Good where slope is 0 to 7 percent, fair where 7 to 12, poor where 12 to 20.	Unsuited	Unsuited	Poor: high frost action.	High: silty
Nenana: NaA, NaB	Good where slope is 0 to 7 percent, fair where 7 to 12.	Good	Good	Good: silty overburden.	Moderate: silty overburden.
NeA, NeB	Good	Poor to fair; excessive fines.	Unsuited	Good: silty overburden.	Moderate: silty overburden.
Salchaket: Sc	Good	Poor; excessive fines.[1]	Unsuited [2]	Fair: frost action	Moderate: silty
Saulich: SuA, SuB, SuC, SuD, SuE, SuF.	Poor: high water table; permafrost.	Unsuited	Unsuited	Poor: high water table; permafrost.	High: permafrost

engineering properties of the soils

Soil features affecting—					
Local roads and streets	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Grassed waterways
High water table; permafrost.	Moderate permeability; permafrost.	Compressible; fair compaction characteristics; susceptible to piping.	Moderate permeability; permafrost.	High water table; permafrost.	Not needed.
Favorable	Very rapid permeability.	High compacted permeability.	Not needed	Very low available water capacity; very rapid permeability.	Shallow to gravel.
Permafrost; strongly sloping to steep.	Strongly sloping to steep.	Susceptible to piping.	Strongly sloping to steep.	High water table; strongly sloping to steep.	Highly erodible; strongly sloping to steep.
High frost action; susceptible to erosion.	Moderate permeability.	Susceptible to piping; compressible.	Not needed	Moderate available water capacity; moderate permeability; nearly level to steep.	Highly erodible; nearly level to steep.
High frost action; susceptible to erosion; gently sloping to steep.	Gently sloping to steep.	Susceptible to piping.	Not needed	Gently sloping to steep.	Highly erodible; gently sloping to steep.
Gently sloping to steep.	Gently sloping to steep.	Susceptible to piping.	Not needed	Gently sloping to steep.	Highly erodible; gently sloping to steep.
High water table; permafrost.	Permafrost	Permafrost; susceptible to piping.	Moderate permeability; permafrost.	High water table; permafrost.	Permafrost.
High water table; permafrost; high frost action.	Very rapid permeability.	High compacted permeability in substratum.	Very rapid permeability in substratum.	High water table; permafrost.	Not needed.
Peat; permafrost; high water table.	Permafrost	Peat; permafrost	Not suitable	Peat	Not needed.
Most features favorable.	Very rapid permeability.	Very high compacted permeability.	Not applicable	Not applicable	Not applicable.
High frost action; sporadic ice masses and uneven subsidence; susceptible to erosion.	Moderate permeability; sporadic ice masses and uneven subsidence and piping.	Susceptible to piping; compressible.	Not needed	Moderate available water capacity; sporadic ice masses and susceptible to uneven subsidence.	Highly erodible; uneven subsidence due to sporadic ice masses.
Moderate frost action.	Very rapid permeability in substratum.	High compacted permeability.	Not needed	Low available water capacity; moderate permeability.	Highly erodible; shallow to gravel.
Moderate frost action; susceptible to blowing in cuts.	Rapid permeability in substratum.	High compacted permeability.	Not needed	Low available water capacity; moderate permeability.	Highly erodible; shallow to sand.
Moderate frost action; occasional flooding.	Moderate permeability; sandy strata.	Fair compaction characteristics; susceptible to piping.	Not needed	Moderate permeability; low available water capacity.	Not needed.
High water table; permafrost; nearly level to steep.	Permafrost; nearly level to steep.	Susceptible to piping; permafrost.	Nearly level to steep; permafrost.	High water table; permafrost.	Highly erodible; permafrost; nearly level to steep.

TABLE 5.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Susceptibility to frost action
	Topsoil	Sand	Gravel	Road fill	
Steese: SvB, SvC, SvD, SvE, SvF.	Good where slope is 3 to 7 percent, fair where 7 to 12, poor where 12 to 45.	Unsuited	Unsuited	Poor: high frost action.	High: silty
Tanana: Ta	Fair: deep permafrost.	Unsuited	Unsuited [2]	Poor: high frost action.	High: permafrost.
Volkmar: Vk	Good	Good	Good	Poor: high frost action in silty material. Good in gravelly substratum.	High

[1] Fine sand or sand is at a depth of 2½ to 6 feet.

samples were chosen to represent the range in properties in the soils of each series. The results of the tests can be used as a guide in estimating the engineering properties of the soils in the survey area. Tests were made for moisture-density relationships, grain-size distribution, liquid limit, and plasticity index.

In the moisture-density tests, a sample of the soil material is compacted several times with a constant compactive effort, each time at a successively higher moisture content. The moisture content is increased until the optimum moisture content is reached. After that, the density decreases with increase in moisture content. The highest density obtained in the compaction test is termed "maximum dry density." Moisture-density data are important in planning earthwork, because generally the soil is more stable if it is compacted to about its maximum dry density when it is at about the optimum moisture content.

Mechanical analyses were made to determine the percentage of clay and coarser material in the soils. The analyses were done by the combined sieve and hydrometer methods. The percentage of clay determined by the hydrometer method should not be used as a basis for naming textural classes of soils.

The tests for liquid limit and plastic limit measure the effect of water on the consistence of soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The *plastic limit* is the moisture content at which the soil material passes from a semisolid to a plastic state. The *liquid limit* is the moisture content at which the material passes from a plastic to a liquid state. The *plasticity* index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

Estimated Soil Properties Significant to Engineering

Table 4 lists the soil series in the survey area and the map symbols for each mapping unit, and it gives estimates of soil properties significant to engineering. The estimates are based partly on test data in table 3 and partly on experience with soils within the Area and experience gained by working with and observing similar soils in other areas.

In general, the estimates in table 4 apply only to the soil depths indicated in the table, but these data are reasonably reliable for soil material to a depth of about 5 feet.

Soil texture is described in table 4 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly sandy loam." "Sand," "silt," "clay," and some of the other terms used in USDA textural classifications are defined in the Glossary of this soil survey.

In table 4, permeability is estimated in inches of water percolation per hour. The data are based on uncompacted soils from which free water has been removed. The estimates are based largely on texture, structure, porosity, and consistence.

Available water capacity, expressed as inches of water per inch of soil depth, is the capacity of a soil to hold water available for use by most plants. It is the estimated amount of water held in a soil between field capacity and the permanent wilting point of plants. Available water capacity data in table 4 are based on 30 inches of usable soil for rooting depth. The roots of

engineering properties of the soils—Continued

Soil features affecting—					
Local roads and streets	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Grassed waterways
High frost action; susceptible to erosion; gently sloping to steep.	Gently sloping to steep.	Susceptible to piping; compressible.	Not needed	Moderate permeability; moderate available water capacity; gently sloping to steep.	Highly erodible; gently sloping to steep.
High frost action; permafrost; high water table.	Permafrost; moderate permeability.	Susceptible to piping; permafrost; compressible.	Moderate permeability; permafrost.	High water table; moderate permeability; permafrost.	Not needed.
High frost action	Rapid permeability in substratum.	High compacted permeability in substratum.	Not needed	Moderate permeability.	Not needed.

[2] Very gravelly sand is at variable depths below a depth of 4 feet.

most crops in the survey area do not penetrate below this depth.

Reaction is the degree of acidity or alkalinity of a soil, expressed as pH value. The pH value, and relative terms used to describe soil reaction, are explained in the Glossary.

Shrink-swell potential, which indicates the volume change to be expected of a soil with changes in moisture content, is not rated in table 4, because all soils in the Goldstream-Nenana Area have low shrink-swell potential.

Engineering Interpretations of the Soils

Table 5 gives ratings of the soils according to their suitability as sources of topsoil, sand, gravel, and road fill. It gives the susceptibility of each soil to frost action. It also lists soil features that affect the suitability of the soils for several engineering practices. The ratings and other interpretations are based on test data in table 3, on estimated soil properties in table 4, and on field experience.

Most of the soils in the Goldstream-Nenana Area formed in silty or very fine sandy material that ranges from a few inches to many feet in thickness. The soils on uplands generally are underlain by uncomformable very channery silt loam. This material is derived from the overlying silty or very fine sandy materials and from weathering of the underlying mica schist. Depth to the very channery material ranges from 40 inches to many feet in Fairbanks, Minto, and Saulich soils; from 20 to 40 inches in the Steese soils; and from 5 to 20 inches in the Ester and Gilmore soils. Depth to unweathered mica schist ranges from 40 inches to many feet in these soils. On alluvial plains, low terraces, moraines, stabilized dunes, and in outwash areas, the soils generally are underlain by loose sandy or gravelly deposits. Depth to these deposits ranges from 40 inches to many feet in Bradway, Goldstream, Salchaket, and Tanana soils; from 10 to 40 inches in Nenana and Volkmar soils; and from 5 to 10 inches in Donnelly soils.

Topsoil refers to soil material, preferably rich in organic matter, that is used as a topdressing on slopes, embankments, lawns, gardens, and the like. The suitability ratings are based mainly on texture and organic-matter content of the soil. Well-drained silty soils, the best sources of topsoil, are well distributed throughout the survey area.

The ratings for sand and gravel are based on the probability that mapped areas of the soils contain sizable deposits of sand and gravel at a depth of no more than 6 feet. Layers of sand and gravel in the Area are at least 3 feet thick. Some soils have little or no sand or gravel in the uppermost 4 or 5 feet, but based on observations made in deep cuts and on knowledge of geology of the Area, some of these are underlain by sand or gravel. The ratings provided in table 4 do not reflect the quality and extent of the deposits or the economic feasibility of removing the deposits.

On alluvial plains in the survey area, some of the soils have a high water table or contain cobblestones or stones that interfere with excavating sand and gravel. Many areas of Salchaket soils contain gravel that can be easily obtained.

On outwash plains, rounded, well-graded gravel generally can be excavated without difficulty from areas of Donnelly, Nenana, and Volkmar soils. On moraines the gravelly material generally contains a higher percentage of fines than the gravelly material on alluvial plains and outwash plains. Upland soils generally are unsuited as sources of gravel.

Road fill refers to soil material that is used to build embankments. The suitability ratings are based on the performance of soil material moved from borrow pits for this purpose. Factors that affect the suitability of a soil for road fill are texture, available water capacity, and depth to permafrost. Organic soils are rated

unsuitable, soils that are shallow to permafrost are rated *poor*, and sandy and gravelly soils that lack permafrost are rated *good*.

Permafrost, or perennially frozen soil, is a major concern in the Goldstream-Nenana Area. On uplands the subsoil of the Ester and Saulich soils is perennially frozen. These soils have north-facing slopes. The subsoil of the sloping Goldstream soils in valleys along secondary drainageways also has permafrost. On alluvial plains and low terraces, large areas of Bradway, Goldstream, and Tanana soils are underlain by permafrost. When moss or other insulating vegetation is removed from the surface of these soils, the uppermost part of the permafrost thaws and commonly causes subsidence of the overlying soil material. Roads and structures constructed on these soils are susceptible to uneven settling unless special construction methods are used. These soils are always nearly saturated in the zone above the permafrost in summer. If the excess water is not removed, especially along roads, even more irregular settling is likely because the hazard of frost heaving is severe in these soils in spring. In areas of Minto soils on foot slopes, irregular subsidence and the formation of deep, steep-walled pits are likely because of the melting of underground masses of ice.

Frost action in soils that have permafrost or that do not have permafrost is a problem throughout the Area. Among the soil properties that influence frost action are texture, porosity, and depth to the water table during periods of freeze. Although a precise correlation has not been established, only the soils in the Goldstream-Nenana Area that contain less than 3 percent of material finer than 0.074 millimeter (No. 200 sieve) are believed to be nonsusceptible to heaving by frost. None of the soils in the Area fully meet this requirement. The well-drained soils on alluvial plains, outwash plains, moraines, and stabilized dunes have a gravelly or sandy substratum, and they generally have low or moderate potential frost action. Soils formed in deep silty and very fine sandy material and that have permafrost and a high water table have high potential frost action.

The factors that affect pond reservoir areas are those features and qualities of undisturbed soils that affect their suitability for water impoundments. Of importance are soil properties that affect seepage. Excessive seepage is a major concern in constructing reservoirs and farm ponds in the Goldstream-Nenana Area. Reservoirs and ponds generally must be lined with impervious material. Throughout most of the survey area, the soils consist of silty or very fine sandy material. They generally are not well suited to embankments, because they are highly susceptible to piping and are compressible. Movement of water through the silty and very fine sandy material is likely to form subsurface channels that can rapidly drain a pond.

Artificial drainage for farming is feasible on some of the somewhat poorly drained and poorly drained mineral soils. Costs and estimated benefits of drainage systems, however, should be carefully considered before construction. It generally is more economical to clear and improve the better drained soils that are suitable for crops than it is to make extensive improvements on wet land. An exception to this is the Tanana soils, where drainage is improved after clearing and subsequent recession of the permafrost table. Drainage of Lemeta peats for farming is not feasible, because these soils are low in fertility and have undesirable physical characteristics for producing the crops commonly grown in the Area.

The sloping soils in the Area are susceptible to severe erosion if the vegetation is removed. Careful planning and design generally are needed to insure that ditches and waterways for the removal of runoff water are safe and adequate. Highway ditches in such soils as the Fairbanks and Minto soils are especially subject to washing unless they are kept in sod. Constructing diversions, waterways, and ditches with gentle slopes helps prevent gullies from forming, though erosion-control structures may be needed in places. Farming and stripcropping on the contour and including grasses in the cropping system help to control erosion in sloping areas. Keeping sod in areas where surface water concentrates also helps to control erosion.

The well-drained silty soils on uplands, including the Fairbanks and Steese soils, are not well suited to the off-road movement of vehicles and heavy equipment, because much of the terrain is strongly sloping to steep. In addition, these soils are dusty when dry and slippery when wet. On uplands and alluvial plains, the soils that are underlain by permafrost are wet throughout the summer and can be traversed only by vehicles designed to operate in wet areas. Well-drained soils on outwash areas and alluvial plains, including the Salchaket, Donnelly, and Nenana soils, generally can be traversed by vehicles and heavy equipment after the ground has thawed in spring.

Use of the Soils as Woodland [2]

This section contains interpretations of the soils of the survey area used as woodland. Native tree species, understory vegetation, site quality, natural competition from undesirable plants, mortality of tree seedlings, limitation to the use of heavy equipment, and hazards of erosion and windthrow are described.

With the discovery of gold in the Tanana Valley and the subsequent growth in population of the Area, man's use of the forest increased. In the early days of the gold rush and settlement, the forest was used mainly for house logs, rough lumber, and fuel wood. All tree species were used for fuel, but white spruce was the main species used for logs and lumber, and this pattern of use has persisted to the present time. The main difference between logging and timber use in the past compared to today is the different route of transportation to the Fairbanks market. In the past, timber was moved on winter haul trails; today timber is moved along the new Anchorage-Fairbanks Highway, from which access roads have been constructed into the

[2] WILLIAM J. SAUERWEIN, regional forester, Soil Conservation Service, and ROYAL HANSEN, State forester's office, Division of Lands, Department of Natural Resources, State of Alaska, helped prepare this section.

timber. A substantial amount of timber is still moved by river barge.

Most of the Goldstream-Nenana Area is forested, but large treeless areas are common. Stands differ in size, age, and density. Sharp boundaries between stands of contrasting age and type are frequently the result of forest fires and abrupt differences in environmental influences.

Quaking aspen *(Populus tremuloides)*, paper birch *(Betula papyrifera)*, and white spruce *(Picea glauca)* are dominant on well-drained soils of uplands and alluvial plains. Quaking aspen is dominant on southerly slopes, and paper birch is dominant on ridges and on slopes with east, northeast, and northwest aspects. White spruce grows on all but north-facing slopes, often in association with birch or aspen. Black spruce *(Picea mariana)* is common on poorly drained soils, both on north-facing slopes of uplands and on alluvial plains. Cottonwood, or balsam poplar *(Populus balsamifera)*, is common on well-drained soils of alluvial plains along the major streams of the Area, and tamarack *(Larix laricina)* grows in a few places where drainage is poor. American green alder *(Alnus crispa)*, thinleaf alder *(Alnus tenuifolia)* and willow *(Salix species)* grow along streams, on the edges of muskegs, and in burned-over areas on uplands. Many poorly drained soils that have a high permafrost table are treeless, and they commonly have a thick cover of moss, sedge tussocks, and low shrubs.

White spruce is the climax species in what can be considered the commercial forest stands in the Area. The best stands average around 90 to 100 feet in height, are between 100 and 200 years old, and average 10,000 to 15,000 board feet per acre. Tree diameters at breast height range from 8 to about 28 inches. If the forest is destroyed by fire, the site naturally reseeds to birch, aspen, or white spruce, or to a mixture of two or all of these species. Since it is more tolerant, white spruce will invade as an understory plant in stands of birch or aspen, and it will eventually become dominant in the stand. It can be assumed that, if left untouched by fire or other disturbances and if the site is adequate, commercial spruce stands will develop on well-drained soils.

Because of extensive fires before and during the gold rush period, most of the trees in the Area are young, but mature stands of paper birch and quaking aspen are in many places, especially on uplands. Stands of white spruce as much as 300 years old are on some well-drained soils of the Tanana River flood plain.

In the course of the soil survey, age and height of trees were determined in plots on each soil considered to be suitable for commercial woodland. In all, 52 plots, each containing 3 to 6 trees, were observed. Largely on the basis of this information, each soil was rated as to its ability to produce aspen, paper birch, and white spruce. Published yield tables are available for these species (*4*, *5*).

Site Class

The relative measure of a soil's ability to produce wood can be expressed by site classes. Under this system, the soil with the greatest productive capacity is placed in site class 1, and the lowest, in site class 5. Soils in classes 2, 3, and 4 have intermediate capacities. The grouping of soils into site classes is based on the average total height of the dominant trees in the stand at the age of 100 years for white spruce and 50 years for quaking aspen and paper birch. These are the largest trees; their crowns form the general level of the forest canopy and, in a few places, extend above it.

The average annual yield per acre for unmanaged, well-stocked stands of white spruce at the age of 100 years is shown in table 6, and that for well-stocked stands of aspen and paper birch at the age of 50 years is shown in table 7. Data from these tables and from the average site index shown in the descriptions of woodland suitability groups can be used to estimate the productivity of a soil for wood crops.

Although yield tables are not available for cottonwood, 19 trees in 5 plots were measured. These trees had an average age of 92 years and an average height of 89 feet.

In many wooded areas, inadequate natural regeneration results in an understocked stand. Such stands produce less wood per acre than is shown in tables 6 and 7. Under improved management, natural regeneration is supplemented where needed, or it is replaced by planting and seeding. The resulting fully stocked stand is protected from fire, insects, and disease. This level of management can be expected to produce wood in quantities greater than shown in tables 6 and 7.

TABLE 6.—*Board-foot volume per acre of white spruce*

[Trees are larger than 8.5 inches diameter at breast height from a 1-foot stump to a 6-inch top, inside bark, by age and site index, Interior Alaska. From Farr (*4*)]

Age (years)	Site index (feet)					
	50	60	70	80	90	100
30	---	---	---	---	---	---
40	---	---	---	---	---	2,349
50	---	---	---	---	2,500	5,375
60	---	---	---	1,864	4,951	8,402
70	---	---	623	3,801	7,403	11,428
80	---	---	2,106	5,738	9,855	14,455
90	---	---	3,590	7,675	12,306	17,482
100	---	1,138	5,073	9,612	14,758	20,508
110	---	2,228	6,556	11,549	17,209	23,535
120	---	3,317	8,039	13,486	19,661	26,561
130	79	4,407	9,522	15,424	22,112	29,588
140	835	5,496	11,005	17,361	24,564	32,615
150	1,592	6,586	12,488	19,298	27,015	35,641
160	2,349	7,675	13,971	21,235	29,467	38,668
170	3,105	8,765	15,454	23,172	31,918	---
180	3,862	9,855	16,937	25,109	34,370	---

Volume $= 9757.8 + 0.030266S^2A$
where: S = site index
A = average age of at least six tallest white spruce trees.
$R^2 = 0.854$ (Basis, number of plots = 89)

TABLE 7.—*Cubic-foot volume per acre of birch and aspen*

[Trees are larger than 6.5 inches diameter at breast height. From Gregory and Haack (*5*)]

Age (years)	Birch site index (feet)				Aspen site index (feet)				
	35	45	55	65	35	45	55	65	75
30	---	---	---	---	--	---	---	---	--
35	---	---	---	---	--	---	---	---	314
40	---	---	---	374	--	---	---	198	718
45	---	---	---	578	--	---	---	518	1,178
50	---	---	---	782	--	---	---	876	1,690
55	---	---	249	987	--	--	454	1,271	2,256
60	---	---	395	1,191	--	---	732	1,704	2,877
65	---	110	542	1,395	--	131	1,034	2,175	3,552
70	107	208	688	1,600	--	312	1,361	2,684	---
75	166	306	834	1,804	--	508	1,712	3,230	---
80	225	404	980	2,008	--	717	2,086	3,814	---
85	284	502	1,127	2,212	--	940	2,485	---	---
90	344	600	1,273	2,417	--	1,176	2,908	---	---
95	403	698	1,419	2,621	--	1,425	3,355	---	---
100	462	796	1,565	2,825	--	1,688	---	---	---

Birch volume $= 1950.64 - 87.38303\ S + 0.00899\ S^3 + 0.00967\ S^2A$
where: S = Site index
A = Average age
$R^2 = .922$ (Basis, number of Plots = 70)
Aspen volume $= -1007.82 - 0.00661\ SA^2 + 0.00028S^2A^2$
where: S = Site index
A = Average age
$R^2 = .902$ (Basis, number of plots = 45)

Under a high level of management, yields may be more than double those shown in tables 6 and 7. Under this level of management, fully stocked stands are not only protected from fires, insects, and disease, but they are also thinned, fertilized, and improved through intermediate harvest cuttings. The trees may also be pruned to improve the quality of the wood. Soils suited to a high level of management generally have slopes of less than 30 percent. They have moderate to high production potential and few serious limitations to use as woodland. In this category are the soils in woodland suitability groups 1w2, 2o1, 2o2, and 3o1.

On soils that slope more than 30 percent or that are wet or very shallow, the difficulty of applying high levels of management are increased. In this category are soils of woodland suitability groups 3w2, 3f2, 3r3, 4d3, and 4f2.

Limitations and Hazards

Five major factors that affect suitability of a site for wood products are related to the soils. These factors are equipment limitations, plant competition, seedling mortality, and the hazards of windthrow and soil erosion. These factors are discussed for each group of soils under the heading "Woodland Suitability Groups."

Equipment limitations are based on soil characteristics that restrict the use of logging equipment for planting and harvesting wood crops, for constructing roads; and for controlling fires. Limitations are given a rating of slight, moderate, and severe. A rating of *slight* means that heavy equipment should not be used in wet periods. A rating of *moderate* means that use of equipment is moderately restricted by slope, wetness, stoniness, or other physical properties of the soils, and by risk of injury to the soils or trees. A rating of *severe* means that special equipment is needed for managing or harvesting trees and that the use of this equipment is severely restricted by slope, wetness, stoniness, or other physical properties of the soils.

Plant competition is the invasion or growth of undesirable plants on different kinds of soil when openings are made in the canopy. A rating of *slight* means that competition does not prevent adequate natural regeneration and early growth of trees, or it does not interfere with adequate development of planted seedlings. A rating of *moderate* means that competition from undesirable plants hinders but does not prevent the growth and establishment of desirable tree seedlings and the eventual development of fully stocked stands. A rating of *severe* means that undesirable plants prevent adequate natural or artificial regeneration without intensive preparation and maintenance of the site.

Seedling mortality refers to the loss of naturally occurring or planted tree seedlings as influenced by kinds of soil or topography when plant competition is assumed not to be a limiting factor. A rating of *slight* means that the expected seedling mortality is 0 to 25 percent; a rating of *moderate* means that the expected seedling mortality is between 25 and 50 percent; and a rating of *severe* means that it is more than 50 percent.

Windthrow hazard refers to the danger of trees being blown over by wind. The rating is *slight* if trees are not expected to be blown over by commonly occuring winds. A rating of *moderate* means that some trees are expected to be blown over during periods when wind is excessive and the soils are wet. A rating of *severe* means that many trees are expected to be blown over during periods when the soil is wet and the velocity of the wind is moderate to high.

Erosion hazard refers to the degree of potential soil erosion. The rating is *slight* where problems of erosion control are not important. A rating of *moderate* means that some attention must be given to prevent unnecessary soil erosion. A rating of *severe* means that intensive treatments and specialized equipment must be used and that methods of operation must be planned to minimize deterioration of the soils.

Woodland Suitability Groups

Soils in the survey area have been placed in woodland suitability groups mainly according to their potential productivity, primarily for white spruce. A woodland suitability group consists of soils that have about the same capability for producing a similar kind of wood crop and that need about the same kind of management.

Woodland suitability groups are identified by a three-digit designation, for example, 2o1. The first digit is a numeral that corresponds to the site class as determined from measurements of tree heights in plot studies. The second digit in the designation is a lowercase letter, *o*, *w*, *d*, *f*, or *r*. The letter *o* means that the

soils in the group have no significant limitations to woodland management; *w* means that woodland management is limited by excessive wetness; *d* means that woodland management is limited by restricted rooting depth; *f* means that woodland management is limited by the presence of gravel or stones; and *r* means that woodland management is limited by steep slopes. The third digit is a numeral that separates the groups according to degrees of difficulty in applying woodland management. The numeral 1, for example, means that woodland management is less difficult to apply than if the numeral were 2 or 3.

In the following paragraphs, the woodland suitability groups of the Area are described. Not all soils in the survey area have been placed in these groups, because some of the soils are too shallow, too wet, or too cold to produce commercial stands of timber. The soil series in each group are mentioned in the description of each woodland suitability group. The woodland suitability group in which each soil has been placed can be found in the "Guide to Mapping Units" at the back of this survey.

WOODLAND SUITABILITY GROUP 1w2

This group consists of Minto silt loams that have slopes of less than 20 percent. These moderately well drained soils are subject to seepage from higher areas. Permeability and available water capacity are moderate. Runoff is slow to rapid, and the hazard of erosion is slight to severe, depending on slopes. The water table is high in spring.

Paper birch grows in clear stands or is codominant with white spruce in areas of these soils. Stands of black spruce are common. The understory includes low shrubs, mosses and lichens, willows, grasses, and horsetail.

This soil is in site class 1 for paper birch. The site index for paper birch is about 64, but site index has not been determined for white spruce.

Equipment limitations are moderate. The soil is generally wet for a few weeks in spring, but in winter it is frozen and can support logging equipment. In summer the soil is generally dry enough for vehicular traffic, but heavy summer showers make trails slippery and occasionally impassable for 2 or 3 days.

Plant competition is moderate for white spruce. A thick accumulation of moss on the soil surface under mature stands of white spruce will likely result in their replacement by stands of black spruce. Under good management, however, mature trees are harvested, the slash is removed, and mossy seedbeds are scarified. Natural regeneration of white spruce can then occur.

Seedling mortality is slight. Natural or planted seedlings generally have ample moisture and other good growing conditions during most of the growing season.

The hazard of windthrow is slight. Rooting depth is shallow, but wind gusts are rarely strong enough to blow down the trees.

The mineral soil should not be disturbed unnecessarily. Sheet erosion and pitting as a result of melting subsurface ice masses may occur if the ground cover is completely removed. Gully erosion is likely to result if roads, skid trails, and landings are not carefully located, constructed, and maintained.

WOODLAND SUITABILITY GROUP 2o1

Salchaket very fine sandy loam is the only soil in this group. This soil is nearly level and well drained, but it is subject to periodic flooding. Permeability is moderate, and available water capacity is low. Runoff is slow, and the hazard of water erosion is slight except on streambanks.

White spruce is the dominant tree growing on this soil, although patches of cottonwood and paper birch grow in a number of places. The understory includes willow, alder, low shrubs, hypnum moss, and horsetail.

This soil is in site class 2 for white spruce. The site index for white spruce is about 94.

Equipment limitations are moderate. Access to most areas of this soil is by water. The soil is not easily damaged by heavy equipment.

Plant competition is low to moderate. As white spruce matures, hypnum moss covers the soil surface and reduces the number of naturally occurring seedlings.

Seedling mortality is moderate. Frequent deposits of alluvial material retard natural regeneration, so planting may be necessary for development of a full stand.

The hazard of windthrow is slight. Rooting depth is moderately deep, and wind gusts rarely exceed 35 miles per hour.

Trees should not be harvested immediately adjacent to streams because of the danger of accelerated streambank erosion. Roads and trails cannot be located near sloughs and former stream channels. Roads are subject to damage by floods.

WOODLAND SUITABILITY GROUP 2o2

Volkmar silt loam is the only soil in this group. This soil is moderately well drained. Permeability is moderate in the silty material and rapid in the underlying gravelly coarse sand. Available water capacity is moderate. Runoff is slow, and the hazard of erosion is slight.

Black spruce is generally the dominant forest tree, but in places mixed stands of birch and white spruce dominate. The understory includes willow, low shrubs, forbs, hypnum moss, and lichens.

This soil is in site class 2 for white spruce. The site index for white spruce is about 87, and for paper birch it is about 61.

Equipment limitations are moderate. During the spring breakup, ungravelled roads and trails become impassable. Heavy summer showers make these roads and trails slippery and occasionally impassable for 2 or 3 days. Rooting depth is shallow, and roots are easily damaged by heavy equipment. Skid trails should be kept to a minimum.

Plant competition for white spruce is moderate to severe. As white spruce forests mature and the moss carpet thickens, black spruce invades. Unless mineral soil is exposed by scarification, white spruce will not regenerate. Under good management the forest is harvested when it matures, the slash is disposed of, and

the seedbed is scarified. Some planting and thinning may be required to insure full and vigorous stands.

Seedling mortality is slight. Good moisture conditions generally favor a high survival rate of seedlings.

The windthrow hazard is slight even though rooting depth is fairly shallow, because wind gusts rarely exceed 35 miles per hour.

WOODLAND SUITABILITY GROUP 3o1

This group consists of Fairbanks, Gilmore, and Steese soils with slopes of 0 to 30 percent. These soils are well drained. Permeability and available water capacity are moderate. Runoff is slow to rapid, and the hazard of erosion is slight to severe, depending on slope.

Some of the better stands of white spruce are on these soils along with good stands of paper birch and quaking aspen. Pure stands of each species occur, but most stands are mixed. The understory includes alder, low shrubs, grasses, and, in places, hypnum moss and lichens. Under quaking aspen it may consist primarily of highbush cranberry, and under birch it may be mainly grasses.

This soil is in site class 3 for white spruce. The site index for white spruce ranges from 75 to 90, and for quaking aspen and paper birch, it ranges from 55 to 70.

Equipment limitations are moderate. During the spring thaw, ungravelled roads and trails become impassable for as long as 2 or 3 days. Rooting depth is fairly shallow, and roots can be easily damaged by repeated passes of heavy-tracked vehicles.

Plant competition for white spruce is moderate. Natural regeneration of this species after harvest can take place if slash is removed and the seedbed is scarified to expose mineral soil.

Seedling mortality is moderate. Soil moisture is generally ample for good growth in spring. Prolonged dry periods may occur during summer, and this probably is the period when seedling mortality is highest. Forest fires are most common during these dry periods.

The windthrow hazard is slight. Winds are rarely strong enough to damage healthy trees.

The hazard of erosion is slight to severe, increasing as slope increases. Because the soils are highly erodible when cleared, road construction and design are critical on steeper soils. Since most erosion occurs during the spring thaw, roads should be provided with adequate cross drainage and should have no sustained steep grades. To minimize erosion from yarding operations. the main swing trails should be placed on the tops of ridges. These trails should be cross ditched when not in use. Skid trails on side slopes should be laid out in a herringbone pattern.

WOODLAND SUITABILITY GROUP 3w2

Tanana silt loam is the only soil in this group. This somewhat poorly drained soil is underlain by permafrost. It is subject to periodic flooding. Permeability and available water capacity are moderate. Runoff is slow. The water table is high, especially during spring, but it normally recedes to a moderate depth in midsummer.

Black spruce is the dominant tree on this soil, but it is often mixed with paper birch and willows. A few areas support stands of white spruce. Recently burned areas have a thick stand of alder. The understory includes low shrubs, grasses, horsetail, and hypnum moss.

This soil is in site class 3 for white spruce. The site index for white spruce is about 79.

Equipment limitations are moderate. The spring breakup and, in some years, floods keep the soil too wet for heavy equipment for several weeks. During summer the soil generally supports heavy-tracked vehicles.

Plant competition is moderate to severe for white spruce after it has been established. Good stands of white spruce and birch can be established where fires or clearing have destroyed the native vegetation and the mossy mat on the forest floor. In some places artificial drainage is necessary.

Good management for white spruce requires scarification of seedbeds to aid natural regeneration.

Seedling mortality is moderate, largely because fresh alluvium is deposited during floods. Some planting may be required to maintain full stands of white spruce. Soil moisture conditions generally are adequate throughout the growing season.

The windthrow hazard is slight. Rooting depth is fairly shallow, but winds are rarely strong enough to topple trees.

The hazard of erosion is slight, but areas immediately adjacent to streams may be subject to streambank erosion. Trees in such areas help stabilize the banks.

WOODLAND SUITABILITY GROUP 3f2

This group consists of Nenana silt loams and Nenana silt loams, sandy substratum, with slopes of 0 to 12 percent. These soils are shallow over gravel or sand and are well drained. Permeability is moderate in the silty material and rapid or very rapid in the underlying sand or very fine sand, and available water capacity is low. Runoff is slow to medium.

Most areas of this soil have been burned, and they now support a forest of young quaking aspen. The understory includes white spruce, willow, low shrubs, forbs, and grasses. White spruce eventually become dominant in these areas if they are protected from fire and other disturbances.

This soil is in site class 3 for white spruce. The site index for white spruce is about 83, for aspen, about 57, and for paper birch, about 50.

Equipment limitations are moderate. During spring thaw the soils are wet and generally do not support heavy equipment without serious damage to tree roots. Ungravelled roads and trails are generally impassable during this period. Heavy summer showers may make the trails impassable for 2 or 3 days.

Plant competition is moderate for white spruce. As openings occur in the forest canopy, natural regeneration of white spruce should occur. If the aspen is harvested, slash disposal and scarification help aid regeneration.

Seedling mortality is moderate. Spring moisture is normally sufficient for good growth. During summer, however, soil moisture may be deficient. It is during this period that seedling mortality increases as a result of droughty soil conditions.

The windthrow hazard is slight. Wind gusts are rarely strong enough to down healthy trees.

Disturbance of the surface layer should be kept to a minimum to protect tree roots and reduce soil erosion. On sloping soils, well-designed, constructed, and maintained swing trails, skid trails, and landings protect the soil from erosion.

WOODLAND SUITABILITY GROUP 3r3

This group consists of Fairbanks, Gilmore, and Steese soils with slopes ranging from 30 to 45 percent. These well-drained soils are, for the most part, at higher elevations on uplands, but some areas are adjacent to the flood plain of the Tanana River.

Soil properties, site index, and forest characteristics are essentially the same as in less steep phases of these soils (see woodland suitability group 3o1). On steep soils, however, management is very difficult. Equipment limitations are severe, and the hazard of erosion is very severe. If trees are harvested, great care is needed in locating, constructing, and maintaining roads and trails.

WOODAND SUITABILITY GROUP 4f2

This group consists of Donnelly silt loams with slopes of 0 to 45 percent. These soils are very shallow and excessively drained. Permeability is moderate in the silty material and very rapid in the underlying very gravelly coarse sand. Available water capacity is very low. Runoff is generally slow, but it ranges from very slow to rapid.

The forest consists dominantly of paper birch, quaking aspen, and white spruce. The cover is sparse in areas of recent fires. The understory includes willow, low brush, and thin patches of alder.

This soil is in site class 4 for white spruce. The site index for white spruce is about 70. For aspen and probably for birch, it is 42.

Equipment limitations are slight. This soil supports heavy equipment most of the year, except for a short period during the spring thaw. During this period, heavy traffic could result in severe damage to tree roots, which are mostly at shallow depths.

Plant competition is moderate for white spruce. After fires, quaking aspen and paper birch tend to regenerate naturally. White spruce usually does not produce a full stand until after the aspen and birch have matured. Artificial regeneration of white spruce greatly reduces competition from other forest species and reduces the time required to produce marketable trees.

Seedling mortality is moderate to high. These soils are droughty during part of the summer growing season, and seedling mortality is probably highest during these dry periods.

The windthrow hazard is slight even though the rooting depth is impeded by gravel at a very shallow depth.

To prevent damage to tree roots, disturbance of the surface layer should be kept to a minimum. Design, construction, and maintenance of roads and trails are an important part of the timber harvesting operation. On steep slopes, even moderate erosion destroys the productive capacity of the soil.

WOODLAND SUITABILITY GROUP 4f3

This group consists of Gilmore silt loams, very shallow, that have slopes ranging from 3 to 45 percent. These well-drained soils are principally at higher elevations in the uplands, on ridgetops and the slopes immediately below them. Permeability is moderate, and available water capacity is low. Runoff is rapid to very rapid, and the hazard of erosion on cleared soils is severe to very severe.

The soils support forests of white spruce, paper birch, and quaking aspen. Pure stands of each species occur, but in most areas the forest is mixed. Much of it is regrowth following severe fires within the past 50 years. The understory includes alder, low shrubs, and grasses.

Soils in this group are in site class 4 for white spruce. The site index for white spruce is less than 75, and for birch and aspen it is less than 55.

Equipment limitations are moderate to severe, mainly because the soils are steep. Rooting depth is shallow, and roots may be damaged by heavy equipment.

Plant competition for white spruce is moderate. Birch and aspen tend to overshadow and retard the early growth of the more commercially valuable white spruce during regrowth after fires. Eventually, however, white spruce will become dominant.

Seeding mortality is moderate. Soil moisture is normally adequate in spring, but the soils tend to be droughty in midsummer. This is probably the period of greatest seedling mortality.

The windthrow hazard is slight, even on ridgetops. There is no evidence of wind damage to healthy trees in the Area.

The erosion hazard is severe to very severe. The silty material beneath the forest litter is highly erodible, and loss of even a few inches of soil will expose the very channery silt loam that has limited capacity to sustain growth. Properly designed and placed roads and skid trails minimize soil loss during logging operations.

Formation and Classification of Soils

In this section the factors that have affected the formation of soils in the Goldstream-Nenana Area are discussed, and important processes in the differentiation of soil horizons are briefly described. Then, the current system of soil classification is explained, and the soil series represented in the survey are placed in some of the categories of this system. The soil series of the Goldstream-Nenana Area, including a profile representative of each series, are described in the section "Descriptions of the Soils."

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic forces. The characteristics of the soil at any

given point are determined by the interaction of five major factors: (1) parent material, (2) climate, (3) plants and animals, (4) relief, and (5) time. Also important are the cultural environment and man's use of the soil (*6*).

Climate and plants and animals are the active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and, in places, through subsequent transportation by water and wind, and they slowly change it into a natural body with genetically related horizons. The effects of climate and plants and animals are conditioned by relief. The soils in low-lying areas of the Goldstream-Nenana Area, for example, are quite different from those on the well-drained uplands because they have a permanently high water table. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed to change parent material into soil. Generally, a long time is needed for distinct horizons to form.

Parent material

Parent material is the unconsolidated mass from which a soil forms. It determines the limits of the chemical and mineral composition of the soil.

The soils in the Goldstream-Nenana Area formed mainly in alluvial material and loess. These materials are micaceous because many of the rocks in the Area and those in the areas of origin of these materials contain significant amounts of mica. Fairbanks, Gilmore, Nenana, Steese, and Volkmar soils on uplands and outwash plains formed in loess derived from glacial outwash. Tanana and Salchaket soils on broad alluvial plains along the major rivers of the Area formed in water-deposited sand and silt derived principally from glacial action. Minto soils, on foot slopes, formed mainly in silty material washed from nearby hillsides. The peats in the Lemeta series are in depressions on broad alluvial plains.

Climate

The Area has a continental climate characterized by long, cold winters and short, warm summers. The total annual precipitation is only about 12 inches, about half of which falls as rain in summer. Winds are light in the northeastern part of the Area, but strong winds are common in all seasons in the southwestern part. Uncultivated, well-drained soils generally are moist throughout the summer, but they are likely to be dry in years of exceptionally low rainfall. Other soils in the Area are moist or wet in summer. The soils in most cleared fields, however, are deficient in moisture part of each year.

Plants and animals

All of the well-drained soils and most of the moderately well drained soils in the Area formed under vegetation that consisted mainly of paper birch, quaking aspen, and white spruce. The somewhat poorly drained Tanana soils support stunted stands of these trees mixed with black spruce, tamarack, and willow. These soils also have a dense cover of grasses, low shrubs, and moss. Some areas of the poorly drained Goldstream and Goodpaster soils and the very poorly drained Lemeta soils support sparse stands mainly of black spruce, but other areas are treeless. These soils have a ground cover of moss, sedge tussocks, and shrubs.

Relief

In this survey area, the influence of relief on soil formation is strongest in its effect on natural drainage. Soils on uplands that have north-facing slopes receive much less sun than soils that have south-facing slopes. Ester and Saulich soils, for example, have north-facing slopes. They are underlain by permafrost in most places, and they are always cold and wet. In contrast, most of the soils with other aspects lack permafrost, and are moderately well drained or well drained (*7*). Goldstream and Tanana soils on broad, low, alluvial plains have a perennially frozen substratum. These soils are somewhat poorly drained or poorly drained. In the well-drained Salchaket soils, which are in slightly higher positions on levees along rivers, permafrost is deep or is not present.

Time

A long time is needed for formation of soils that have distinct horizons. The length of time that parent material has been in place generally is reflected in the degree of formation of the soil profile.

Only the southwestern part of the Goldstream-Nenana Area has been glaciated, but all soils in the Area probably formed since the maximum glacial advance from the mountains to the south. The well-drained Fairbanks, Steese, and Gilmore soils of the uplands and outwash plains, on which loess is no longer being deposited, are the oldest soils. They have been in place long enough to develop B horizons that have clay accumulation in thin bands. The well-drained Nenana soils and the excessively drained Donnelly soils are intermediate in age. They have been in place for a sufficient length of time to develop B horizons, but they lack clay bands. Soils forming in recent deposits of alluvial plains are young and have not had time for horizon differentiation. The poorly drained soils on uplands and alluvial plains show weak horizon development.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and response to kinds of treatment.

Thus, in classification, soils are placed in narrow categories that are used in detailed surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways. The soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*3*) and later revised (*12*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. It is under continual study. Therefore, readers interested in this system should search the latest literature available (*14*). The soil series of the Goldstream-Nenana Area are placed in some categories of the current system in table 8.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar origin are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available. The categories of the current system are briefly defined in the paragraphs that follow.

ORDERS: Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Three exceptions, the Entisols, Inceptisols, and Histosols, are present in many kinds of climate. The three soil orders represented in the Goldstream-Nenana Area are Entisols, Histosols, and Inceptisols.

Entisols have few, if any, clearly expressed characteristics. In the Goldstream-Nenana Area, these soils are represented by *Typic Cryofluvents,* which are well-drained, stratified soils on alluvial plains.

Histosols consist primarily of organic material. They are represented in the Goldstream-Nenana Area by *Pergelic Cryofibrists,* which are perennially frozen peats that form mainly from fibrous remains of sphagnum moss and sedges.

Inceptisols are soils in which the present material has been modified. They have weakly expressed horizons. In the Goldstream-Nenana Area *Cryaquepts* and *Cryochrepts* are recognized. *Aeric Cryaquepts* are brownish in color and are mottled, a characteristic associated with wetness. *Pergelic Cryaquepts* are perennially frozen. They are gray or neutral, and have brown or olive-gray mottles. *Histic Pergelic Cryaquepts* are perennially frozen. They have a fairly thick accumulation of organic material on the surface, are neutral or gray, and have brown or olive mottles. *Typic Cryochrepts* are well drained, and they are brown. *Alfic Cryochrepts* have a slight accumulation of clay in thin bands in the subsoil. They are well drained, and their surface layer and subsoil are brown.

SUBORDERS: Each order is divided into suborders, primarily on the basis of those soil characteristics that seem to produce classes having the greatest genetic

TABLE 8.—*Classification of soil series*

Series	Current classification		1938 classification	
	Family	Subgroup	Order	Great group
Bradway	Loamy, mixed, nonacid	Pergelic Cryaquepts	Inceptisols	Low-Humic Gley soils.
Donnelly	Sandy-skeletal, mixed	Typic Cryochrepts	Inceptisols	Subarctic Brown forest soils.
Ester	Loamy-skeletal, mixed, acid	Histic Pergelic Cryaquepts	Inceptisols	Humic Gley soils.
Fairbanks	Coarse-silty, mixed	Alfic Cryochrepts	Inceptisols	Subarctic Brown forest soils.
Gilmore	Loamy-skeletal, mixed	Alfic Cryochrepts	Inceptisols	Subarctic Brown forest soils.
Goldstream	Loamy, mixed, acid	Histic Pergelic Cryaquepts	Inceptisols	Humic Gley soils.
Goodpaster	Loamy over sandy or sandy-skeletal, mixed, nonacid.	Histic Pergelic Cryaquepts	Inceptisols	Humic Gley soils.
Lemeta	Dysic	Pergelic Cryofibrists	Histosols	Bog soils.
Minto	Coarse-silty, mixed, nonacid	Aeric Cryochrepts	Inceptisols	Subarctic Brown forest soils intergrading with Low-Humic Gley soils.
Nenana	Coarse-silty over sandy or sandy-skeletal, mixed.	Typic Croyochrepts	Inceptisols	Subarctic Brown forest soils.
Salchaket	Coarse-loamy, mixed, nonacid	Typic Cryofluvents	Entisols	Alluvial soils.
Saulich	Loamy, mixed, nonacid	Histic Pergelic Cryaquepts	Inceptisols	Humic Gley soils.
Steese	Coarse-silty, mixed	Alfic Cryochrepts	Inceptisols	Subarctic Brown forest soils
Tanana	Loamy, mixed, nonacid	Pergelic Cryaquepts	Inceptisols	Low-Humic Gley soils.
Volkmar	Coarse-silty over sandy or sandy-skeletal, mixed, nonacid.	Aeric Cryaquepts	Inceptisols	Subarctic Brown forest soils intergrading with Low-Humic Gley soils.

similarity. The soil properties used to distinguish suborders are mainly those that reflect the presence or absence of waterlogging or soil differences that result from the effects of climate or vegetation.

GREAT GROUPS: The suborders are divided into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. Some horizons used for distinguishing between great groups are those in which (1) clay, iron, or humus have accumulated; (2) a pan has formed that interferes with growth of roots; movement of water, or both; or (3) a thick, dark-colored surface horizon has formed. Other features commonly used are soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), or the dark-red or dark-brown colors associated with soils that formed in material weathered from basic rock.

SUBGROUPS: Great soil groups are divided into subgroups. One of these represents the central, or typic, segment of the group. Other subgroups, called intergrades, have properties of the group, but have one or more properties of another great group, suborder, or order. Subgroups may also be made for soils that have properties that intergrade outside the range of any other great group, suborder, or order.

FAMILIES: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, temperature, and so on.

SERIES: The series is a group of soils that formed from a particular kind of parent material and have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile. The soils are given the name of a geographic location near the place where that series was first observed and mapped.

General Nature of the Area

This section is provided mainly for those who are unfamiliar with the survey area. Factors discussed are physiography and drainage, geology, climate, vegetation, settlement and development, and wildlife.

Physiography and Drainage

Most of the Area lies north of the Tanana River. It consists of rounded hills and ridges dissected by many drainageways. Elevations mostly range from 400 to 1,800 feet, but the highest peak is 2,364 feet above sea level.

Goldstream Creek and Little Goldstream Creek receive much of the runoff water from the hills. These creeks drain in a westerly direction through the Area. Their nearly level valley bottoms and adjoining foot slopes range from 350 to 600 feet above sea level. The Tanana River, the principal drainage channel in the region, receives runoff both from the unglaciated Yukon-Tanana Upland to the north and the glaciated Alaska Range to the south. Its elevation in the survey area ranges from 350 to 400 feet. The southwestern part of the Area, along the Nenana River, includes nearly level flood plains, high terraces or outwash plains, and low moraines. Elevations range from 350 to 1,300 feet.

Permafrost in the Area is discontinuous (*9*). It generally is at a depth of less than 30 inches in the thick silty sediment on alluvial bottoms, in upland drainageways, in areas where slopes face north, and in depressions filled with organic material. In these places, the high permafrost table is preserved by a thick surface layer of moss or other vegetation that serves as insulation. If this material is removed, burned, or disturbed, the permafrost table recedes to a greater depth.

Soils on uplands that have south-facing slopes do not have permafrost, but on colluvial foot slopes, large ice masses are buried in redeposited loess (*10*). If the vegetation is removed, these ice masses melt, and thermokarst topography, characterized by steep-walled pits, sinkholes, and extremely hummocky microrelief, may result.

Geology

The rounded hills and ridges in the northeastern part of the Area, north of the Tanana River, are part of the unglaciated Yukon-Tanana Uplands. The bedrock is chiefly Precambrian Birch Creek schist. Except for a few steep bluffs, most areas of the uplands are covered by a silty micaceous loess derived chiefly from outwash plains south of the Tanana River (*11*). This mantle of loess ranges from a few inches to many feet in thickness on most of the hills and ridges. It is generally thinner in places farther away from and at elevations above the Tanana River and Goldstream Creek. Much of the original loess washed away from steeper soils and accumulated on foot slopes and in upland valleys.

The geology of the southwestern part of the Area, south of the Tanana River, contrasts sharply with the unglaciated northeastern part. Glaciers from the Alaska Range extended into this part of the Area during the Pleistocene era. As they retreated, deposits of sandy and gravelly material were laid down by glacial melt water, and broad outwash plains were formed.

Although moraines and high outwash plains make up much of the Nenana Valley south of the survey area, only a small acreage near Clear Air Force Base is included in the Area. The map area between the base and the Tanana River is part of the combined flood plain of the Nenana and Tanana Rivers. Much of this flood plain is underlain by gravel deposits. Most soils formed in alluvial deposits, but a few low, stabilized sand dunes capped by loessial silt are on the flood plain.

Climate [3]

[3] By ANTON S. PRECHTEL, assistant regional climatologist for Alaska, National Weather Service, U.S. Department of Commerce.

A strong continental climate characteristic of all central and eastern interior sections of Alaska dominates the entire Goldstream-Nenana Area. Temperature extremes, both annual and diurnal, are pronounced. The change from cold to warm seasons is very rapid and marked. This is primarily due to the presence of the Alaska Range to the south, which effectively blocks any maritime influence from penetrating northward into this region.

Annual precipitation totals are light, but so is the evaporation rate. This tends to keep soil moisture adequate most of the time. Furthermore, over half of the annual precipitation falls during the summer growing season.

Temperature and precipitation data for Fairbanks and Nenana, two stations which have climates representative of this Area, are shown in table 9.

Temperatures in the Area warm swiftly in late spring, and similarly, cool rapidly in early fall. Maximum temperatures rise to 70° F or higher on 45 to 55 days of the short summer season. In addition, the almost continuous daylight effectively reduces the number of days required for crops to mature. The sun is above the horizon from 18 to 21 hours daily during the peak growing season. The Goldstream-Nenana Area, in fact, lies within the interior portion of Alaska that has one of the highest cumulative growing degree day totals within the State. The average cumulative growing degree day total at the Fairbanks Weather Service Office is 1,968 using a growing degree base of 40°. Specific growing degree day figures for Nenana are not available, but they are estimated to average around 1,900 to 1,930 a season. These figures compare favorably with the average of 1,939 growing degree days at the Matanuska Experiment Station near Palmer, currently within Alaska's largest and most developed farming district.

The actual growing season length, however, can vary considerably over short distances, due to the effects of local cold air drainage. Cold air drainage can significantly shorten growing seasons at these high latitudes. A good example of this can be found by comparing the average 107-day freeze-free period at the Fairbanks Weather Bureau Airport Station and the noticeably lower 88-day average freeze-free period at the University Experiment Station at College, only 4 miles away. Nenana has an average freeze-free period of 82 days. Local cold air drainage, therefore, becomes a critical factor in determining the length of the growing season for a specific location.

Table 10 gives beginning and ending dates of probabilities for given freezing temperatures at Nenana and Fairbanks. This table shows that for Nenana, the average date of last occurrence in spring of freezing temperatures is May 30, and that the average first occurrence in fall is August 22; while for Fairbanks, the corresponding dates are May 19 and September 2.

Most of the Goldstream-Nenana Area, however, probably experiences an average growing season closer in length to that of Nenana rather than the longer season at Fairbanks. This is particularly true along Goldstream Creek, which is rimmed by high ridges that are conducive to pronounced cold air drainage. Although specific data are not available for Goldstream Creek, it appears likely that occasional light summer frosts do occur in certain isolated spots that are especially prone to excessive cold air drainage. Even Nenana during the period 1931-70 has reported extreme minimum temperatures below freezing at some time during each of the summer months (table 9). Fairbanks airport, however, has never recorded a temperature below freezing during July; and very likely a few other locations not subject to cold air drainage in the Goldstream-Nenana Area have had similarly frost-free Julys to date.

Table 11 shows the probabilities of receiving a given absolute minimum temperature during each of the normal growing season months. For example, an absolute minimum temperature of 31° or lower can be expected at Nenana during July about once every 20 years. This can also be interpolated as 32° once every 15 years by using the stated 33° value that can be expected once every 10 years. Likewise at Fairbanks, only one year in 20 will have an absolute July minimum of 35°. Occasional midsummer minimums dropping into the high thirties are not uncommon, even in areas not subject to cold air drainage. In general, discounting the local effects of cold air drainage, summertime minimum temperatures are lower nearer the Alaska Range, south of Nenana.

It should also be noted that there is a marked decrease in warm-season temperatures with an increase in altitude, especially along northerly slopes. Since the hardiest grain, barley, needs 1,500 growing degree days to mature, it appears unlikely that temperatures are sufficiently warm for crop production above an elevation of 1,200 feet.

Precipitation in the Goldstream-Nenana Area is light when compared with the main farming areas in the United States. Only about 12 inches fall annually (table 9), but the high soil moisture content and the relatively low evaporation rates found here greatly compensate for the light precipitation. Also, half of this annual 12-inch total falls during the main growing season months of June, July, and August. The precipitation during these months falls mostly in showers, and therefore, it can be variable over short distances. Excessively heavy short-duration precipitation is rare. Only once in a hundred years can any location expect to receive more than 1 inch in 1 hour. The maximum 24-hour amounts ever recorded for Fairbanks and Nenana are shown in table 9. On the average, about 100 days annually receive some measurable precipitation, but of this number, about 30 days receive 0.1 inch or more.

At these high latitudes, it is imperative that crops have sufficient moisture to grow rapidly throughout the growing season if they are to mature in time. Experience in the Fairbanks areas has shown that, for the first four or five years after clearing, there is sufficient moisture remaining in the soil from spring snowmelt and thawing frost in the subsoil for the crops to grow rapidly. After this initial period, however, there may be a pronounced shortage of moisture available for plants during the first half of the season if less than

TABLE 9.—*Temperature*

[Data from Fairbanks, elevation 436 feet, and Nenana,

Month	Temperature (°F)							
	Average daily maximum		Average daily minimum		Extreme maximum		Extreme minimum	
	Fairbanks	Nenana	Fairbanks	Nenana	Fairbanks	Nenana	Fairbanks	Nenana
January	–2.2	1.7	–20.7	–17.3	47	45	–66	–66
February	8.0	7.0	–14.7	–15.1	50	54	–58	–63
March	22.8	20.7	–5.1	–6.8	55	55	–49	–59
April	41.1	37.1	18.2	14.6	74	71	–32	–33
May	58.3	56.7	35.7	33.5	90	88	–1	–2
June	70.3	68.4	47.0	44.7	96	98	30	27
July	71.3	70.4	49.4	47.5	[1] 99	94	34	29
August	65.2	64.5	44.5	43.3	87	90	23	23
September	54.0	52.6	34.5	32.9	84	79	12	3
October	33.7	31.4	18.0	15.8	65	64	–28	–28
November	11.2	11.7	–5.4	–4.8	54	54	–43	–49
December	–1.4	–0.6	–18.1	–18.0	58	61	–61	–69
Year	36.0	35.1	15.3	14.2	[1] 99	98	–66	–69

[1] July 1919 at University Experiment Station.

average precipitation fell before freeze-up during the previous fall.

Part of the showery precipitation during summer falls in thunderstorms. Five to 10 thunderstorms occur annually at any one location, but they are normally quite mild in intensity. Hail is infrequent. When it does fall, hail is usually not larger than pea size, and it does not pose significant danger to crops. Unlike thunderstorms over the lower 48 states, any wind gusts accompanying thundershowers over interior Alaska are seldom strong, rarely exceeding 35 mph.

After the first hard freeze, occurring normally during September, temperatures continue to fall rapidly. Winter arrives early, with a permanent snow cover blanketing the landscape from October until April. This snow cover protects dormant vegetation underneath from the extremely low midwinter temperatures that sometimes dip to –60° F. (table 9). More than 3 days in 4 from November through March have temperatures below zero. Total annual snowfall ranges from an average of 70 inches to less than 50 inches. Snow depths generally average less than 20 inches.

Correlating with the rapid plunge in autumn temperatures, a corresponding rapid rise occurs during April and May. April is the driest month of the year, averaging ¼ inch of precipitation or less. This, combined with bright sunshine, quickly melts the snow cover by the end of the month. The transition time from winter to summer is short, and by June, daily maximum temperatures average almost 70°.

Settlement and Development

Nenana is the largest town in the Area. It is on the east bank of the Nenana River at the confluence of the Tanana River. It was originally an Indian village named after the nearby stream. In 1907 the St. Marks Indian Mission was established nearby. In 1916 a base was built for construction of the Alaska Railroad, and this was the beginning of the modern town. Here trains connected with freight and passenger steamers that operated on the Yukon River system. Nenana was and still is a major distribution point for a large part of central Alaska bordering the Yukon River and its principal tributaries.

In 1970 Nenana had a population of about 362 people. The railroad and barge line are still important businesses in the town. Two small lumber mills are located nearby. Clear Air Force Base provides a major source of income. Hunting, fishing, and trapping remain important parts of the total economy.

The Area also includes the village of Anderson and the State Bonanza Creek Experimental Forest. A few homesteads are scattered throughout the Area, and small home gardens are common, but there are no large commercial farms.

and precipitation data

elevation 356 feet. Period of record (both stations), 1931–70]

Precipitation (Inches)													
Average total		Maximum in 24 hours		One year in 10 will have—				Snowfall		Average end-of-month snow depth	
				Less than—		More than—					
Fairbanks	Nenana	Fairbanks	Nenana	Fairbanks	Nenana	Fairbanks	Nenana	Fairbanks	Nenana	Fairbanks	Nenana
0.79	0.65	1.84	1.00	0.08	0.10	1.90	1.75	12.4	9.1	19.4	17.3
.51	.53	0.97	0.67	0.07	0.08	1.35	1.45	9.3	6.9	22.2	20.9
.46	.48	0.92	0.77	0.05	0.03	1.20	1.40	7.5	6.6	16.5	16.8
.29	.33	0.66	1.06	0.01	0.01	0.75	1.00	3.6	3.4	2.1	2.8
.66	.66	0.88	0.76	0.15	0.20	1.32	1.55	.7	.4	0	0
1.39	1.44	1.52	1.75	0.30	0.45	2.60	2.85	0	0	0	0
1.88	2.06	2.16	2.16	0.75	0.75	3.35	3.50	0	0	0	0
2.41	2.50	3.42	3.04	0.80	1.00	3.95	4.40	0	0	0	0
1.03	1.26	1.21	1.57	0.20	0.40	2.00	2.55	.6	.6	0.2	0.4
.82	.65	1.17	0.68	0.15	0.20	1.85	2.10	9.3	6.9	3.6	3.8
.70	.51	0.94	0.55	0.15	0.15	1.95	1.30	11.3	7.5	10.4	9.4
.62	.49	1.25	0.84	0.06	0.03	1.80	1.45	10.2	6.7	16.2	13.9
11.56	11.56	3.42	3.04	---	---	---	---	64.9	48.1	---	---

Wildlife

A variety of wildlife species inhabit the Goldstream-Nenana Area. The different soils provide the necessary variation in vegetation for food and shelter. The number of animals in the Area fluctuates with such environmental conditions as hunting and trapping pressures, weather, predators, feeding conditions, and other factors.

Moose is the most important big game mammal in the Area. It is principally a browser, feeding on willow, birch, and aspen brush in winter and grass, acquatic plants, and other succulent plants in spring and summer. In winter, moose stay at low elevations where browse and snow conditions are more favorable. In spring and summer, the bulls migrate to higher elevations, but the cows remain in thickets at lower elevations where their calves are born.

There are some black bears and a few grizzly bears in the Area. These are omnivorous animals that have a diet that includes large and small mammals, carrion, fish, grass, horsetail, berries, and roots of many plants. Among the other furbearing animals and predatory birds are fox, lynx, wolf, land otter, mink, eagle, hawk, owl, and raven. Other animals in the Area include snowshoe hare, red squirrel, porcupine, weasel, muskrat, beaver, shrew, and mice.

The most important fish are the grayling, northern pike, and salmon. Northern pike are plentiful in some lakes and slow-moving streams. The Tanana River is the primary channel for sea-run salmon to the spawning grounds in the upstream tributaries.

Mosquitoes, flies, ants, bees, and other insects are fairly numerous in the Area. They are an important part of the diet for some of the larger forms of wildlife.

The distribution of wildlife in relation to the different soil associations in the Goldstream-Nenana Area is explained in the following paragraphs. The soil associations are described in the section "General Soil Map," and they are delineated on the General Soil Map that is bound in the back of this survey.

Fairbanks-Steese-Gilmore association.—Wildlife in this soil association is limited to species adapted to upland forest habitat. The Fairbanks, Steese, and Gilmore soils are mostly forested and provide only sparse food for moose except in areas that have been burned fairly recently. These soils provide cover and food for summer songbirds, grouse, marten, red squirrel, weasel, and porcupine. The Ester and Saulich soils that are included in this association produce berries, brush, and thick patches of black spruce used by bear, fox, rabbit, spruce grouse, and summer songbirds. Thick brush also grows along the small streams that cut through steep slopes. Water levels in these streams fluctuate rapidly. These streams have no fish population.

Minto-Goldstream association.—Nearly all wildlife species common to the Area can be found in areas of

TABLE 10.—*Probabilities of last freezing temperatures in spring and first in fall*

Probability	Location	Dates for given probability and temperature				
		32° F or lower	28° F or lower	24° F or lower	20° F or lower	16° F or lower
Spring:						
1 year in 10 later than:	At Nenana	June 11	May 30	May 18	May 6	May 4
	At Fairbanks	May 28	May 14	May 6	May 3	May 2
2 years in 10 later than:	At Nenana	June 7	May 25	May 14	May 3	May 2
	At Fairbanks	May 24	May 11	May 3	May 1	April 28
5 years in 10 later than:	At Nenana	May 30	May 17	May 6	April 28	April 25
	At Fairbanks	May 19	May 6	April 28	April 25	April 21
Fall:						
1 year in 10 earlier than:	At Nenana	July 30	August 24	August 31	September 14	September 16
	At Fairbanks	August 21	September 8	September 13	September 17	September 27
2 years in 10 earlier than:	At Nenana	August 7	August 29	September 5	September 19	September 22
	At Fairbanks	August 26	September 12	September 18	September 23	October 2
5 years in 10 earlier than:	At Nenana	August 22	September 6	September 14	September 26	October 3
	At Fairbanks	September 2	September 19	September 26	October 2	October 10

this soil association, which is on foot slopes and alluvial plains. The Minto soils have dense stands of either paper birch and willow or black spruce and brush. This cover provides habitat for bear, wolf, fox, and lynx. The Goldstream soils produce berries, sedges, and willow brush used by moose, small mammals, songbirds, and other birds. At the borders of small ponds and streams, brush and succulent water-tolerant plants are used by waterfowl, furbearing animals, and moose. Northern pike and grayling inhabit some ponds and streams.

Goldstream-Tanana association.—Wildlife in this soil association is quite similar to that in the Minto-Goldstream association. The Goldstream soils provide a dense cover of black spruce and shrubs or open areas of shrubs, sedge, and moss. Summer songbirds, small mammals, and eagle, falcon, hawk, owl, raven, and ptarmigan are common in these areas. The Tanana soils support vegetation that includes paper birch, willow, and alder brush. Migratory ducks, geese, and other waterfowl use the small ponds and streams for stopover and nesting areas. Furbearing animals and moose feed on the brush and succulent water-tolerant plants in this soil association. Among the fish in these streams are grayling, northern pipe, and salmon.

Nenana-Tanana-Donnelly association.—Wildlife in

TABLE 11.—*Monthly minimum temperature probability during the growing season*

[Data from Fairbanks and Nenana]

Month	An absolute minimum temperature equal to or lower than value shown will occur on an average of once every—							
	2 years at—		5 years at—		10 years at—		20 years at—	
	Fairbanks	Nenana	Fairbanks	Nenana	Fairbanks	Nenana	Fairbanks	Nenana
May	24° F	20° F	18° F	14° F	15° F	11° F	12° F	8° F
June	36° F	33° F	34° F	30° F	33° F	28° F	32° F	27° F
July	41° F	36° F	38° F	34° F	36° F	33° F	35° F	31° F
August	34° F	30° F	30° F	26° F	28° F	24° F	26° F	23° F
September	22° F	17° F	17° F	12° F	15° F	9° F	13° F	7° F

this soil association is somewhat similar to that in the Fairbanks-Steese-Gilmore association. Nenana and Donnelly soils are well drained, and in areas of fairly recent fires, they support young stands of aspen, paper birth, and willow as well as grasses and low-growing shrubs that provide moderate amounts of feed for moose, bear, grouse, rabbit, other mammals, and a variety of songbirds. The Tanana soils in the association support a dense cover of brush, grass, and patches of spruce, paper birch, and alder brush. This soil association is not favorable for waterfowl and furbearing animals that live along lakes and streams. There are no fishing streams.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity. The capacity of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches per inch of soil. Ratings for available water capacity are: high, >3.75 inches for the 30-inch soil profile; moderate, 2.5–3.75 inches; low, 1.25–2.5 inches; and very low, <1.25 inches.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Nutrient, plant. Any element taken in by a plant, essential to its growth and used by it in the production of food and tissue. Nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil, and carbon, hydrogen, and oxygen, obtained largely from the air and water, are plant nutrients.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Permafrost. Layers of soil in which the temperatures are perennially at or below 0° C, whether the consistence is very hard or loose (dry permafrost).

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the series to which the mapping unit belongs. To learn about the management of a capability unit or a woodland suitability group, read the description of that unit or group and also the introduction to the section in which it is described.

Map symbol	Mapping unit	Page	Management group (Capability unit) Number	Management group (Capability unit) Page	Woodland suitability group Number	Woodland suitability group Page
Br	Bradway very fine sandy loam	6	14 (IVw-1)	20	---	--
DoA	Donnelly silt loam, nearly level	6	13 (IVs-1)	20	4f2	35
DoB	Donnelly silt loam, gently sloping	6	12 (IVe-2)	20	4f2	35
DoF	Donnelly silt loam, steep	7	18 (VIIe-1)	21	4f2	35
EsD	Ester silt loam, strongly sloping	7	19 (VIIw-1)	21	---	--
EsE	Ester silt loam, moderately steep	7	19 (VIIw-1)	21	---	--
EsF	Ester silt loam, steep	7	19 (VIIw-1)	21	---	--
FaA	Fairbanks silt loam, nearly level	8	1 (IIc-1)	18	3o1	34
FaB	Fairbanks silt loam, gently sloping	8	3 (IIe-1)	18	3o1	34
FaC	Fairbanks silt loam, moderately sloping	8	5 (IIIe-1)	19	3o1	34
FaD	Fairbanks silt loam, strongly sloping	8	11 (IVe-1)	20	3o1	34
FaE	Fairbanks silt loam, moderately steep	8	16 (VIe-1)	20	3o1	34
FaF	Fairbanks silt loam, steep	8	18 (VIIe-1)	21	3r3	35
GmB	Gilmore silt loam, gently sloping	9	8 (IIIe-4)	19	3o1	34
GmC	Gilmore silt loam, moderately sloping	9	12 (IVe-2)	20	3o1	34
GmD	Gilmore silt loam, strongly sloping	9	12 (IVe-2)	20	3o1	34
GmE	Gilmore silt loam, moderately steep	9	16 (VIe-1)	20	3o1	34
GmF	Gilmore silt loam, steep	9	18 (VIIe-1)	21	3r3	35
GrB	Gilmore silt loam, very shallow, gently sloping	9	12 (IVe-2)	20	4f3	35
GrC	Gilmore silt loam, very shallow, moderately sloping	9	16 (VIe-1)	20	4f3	35
GrE	Gilmore silt loam, very shallow, moderately steep	9	18 (VIIe-1)	21	4f3	35
GrF	Gilmore silt loam, very shallow, steep	10	18 (VIIe-1)	21	4f3	35
GtA	Goldstream silt loam, nearly level	10	14 (IVw-1)	20	---	--
GtB	Goldstream silt loam, gently sloping	10	15 (IVw-2)	20	---	--
GuA	Goodpaster silt loam	11	14 (IVw-1)	20	---	--
Lp	Lemeta peat	11	20 (VIIw-2)	21	---	--
Me	Mine tailings	11	21 (VIIIs-1)	21	---	--
MnA	Minto silt loam, nearly level	12	2 (IIc-2)	18	1w2	33
MnB	Minto silt loam, gently sloping	12	4 (IIe-2)	19	1w2	33
MnC	Minto silt loam, moderately sloping	12	6 (IIIe-2)	19	1w2	33
MnD	Minto silt loam, strongly sloping	12	11 (IVe-1)	20	1w2	33
NaA	Nenana silt loam, nearly level	13	9 (IIIs-1)	19	3f2	34
NaB	Nenana silt loam, gently sloping	13	8 (IIIe-4)	19	3f2	34
NeA	Nenana silt loam, sandy substratum, nearly level	13	7 (IIIe-3)	19	3f2	34
NeB	Nenana silt loam, sandy substratum, gently sloping	13	7 (IIIe-3)	19	3f2	34
Sc	Salchaket very fine sandy loam	13	1 (IIc-1)	18	2o1	33
SuA	Saulich silt loam, nearly level	14	14 (IVw-1)	20	---	--
SuB	Saulich silt loam, gently sloping	14	15 (IVw-2)	20	---	--
SuC	Saulich silt loam, moderately sloping	14	15 (IVw-2)	20	---	--
SuD	Saulich silt loam, strongly sloping	14	17 (VIw-1)	21	---	--
SuE	Saulich silt loam, moderately steep	14	19 (VIIw-1)	21	---	--
SuF	Saulich silt loam, steep	14	19 (VIIw-1)	21	---	--
SvB	Steese silt loam, gently sloping	15	3 (IIe-1)	18	3o1	34
SvC	Steese silt loam, moderately sloping	15	5 (IIIe-1)	19	3o1	34
SvD	Steese silt loam, strongly sloping	15	11 (IVe-1)	20	3o1	34
SvE	Steese silt loam, moderately steep	15	16 (VIe-1)	20	3o1	34
SvF	Steese silt loam, steep	15	18 (VIIe-1)	21	3r3	35
Ta	Tanana silt loam	16	10 (IIIw-1)	20	3w2	34
Vk	Volkmar silt loam	16	9 (IIIs-1)	19	2o2	33

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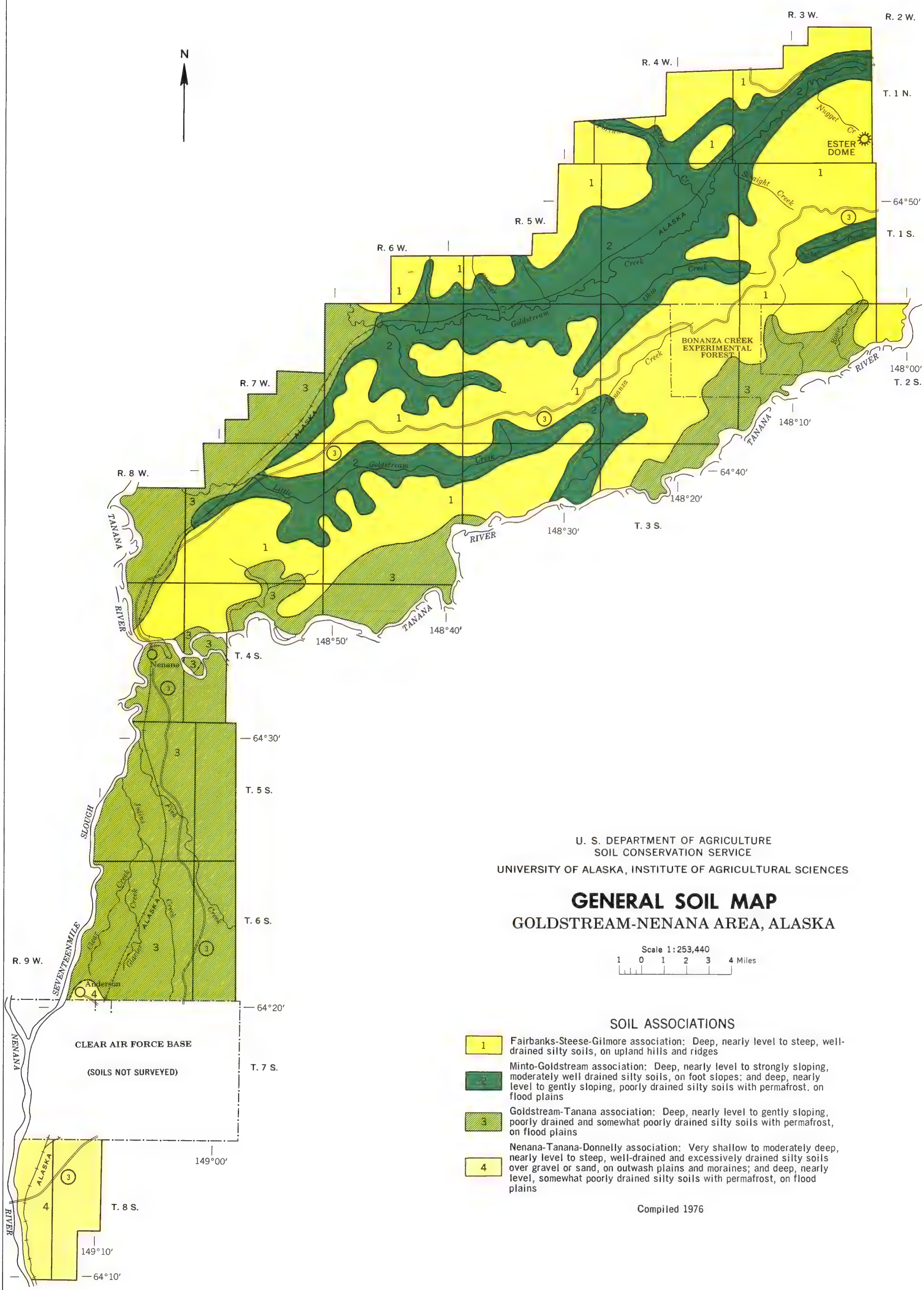


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
UNIVERSITY OF ALASKA, INSTITUTE OF AGRICULTURAL SCIENCES

GENERAL SOIL MAP
GOLDSTREAM-NENANA AREA, ALASKA

Scale 1:253,440
1 0 1 2 3 4 Miles

SOIL ASSOCIATIONS

1 Fairbanks-Steese-Gilmore association: Deep, nearly level to steep, well-drained silty soils, on upland hills and ridges

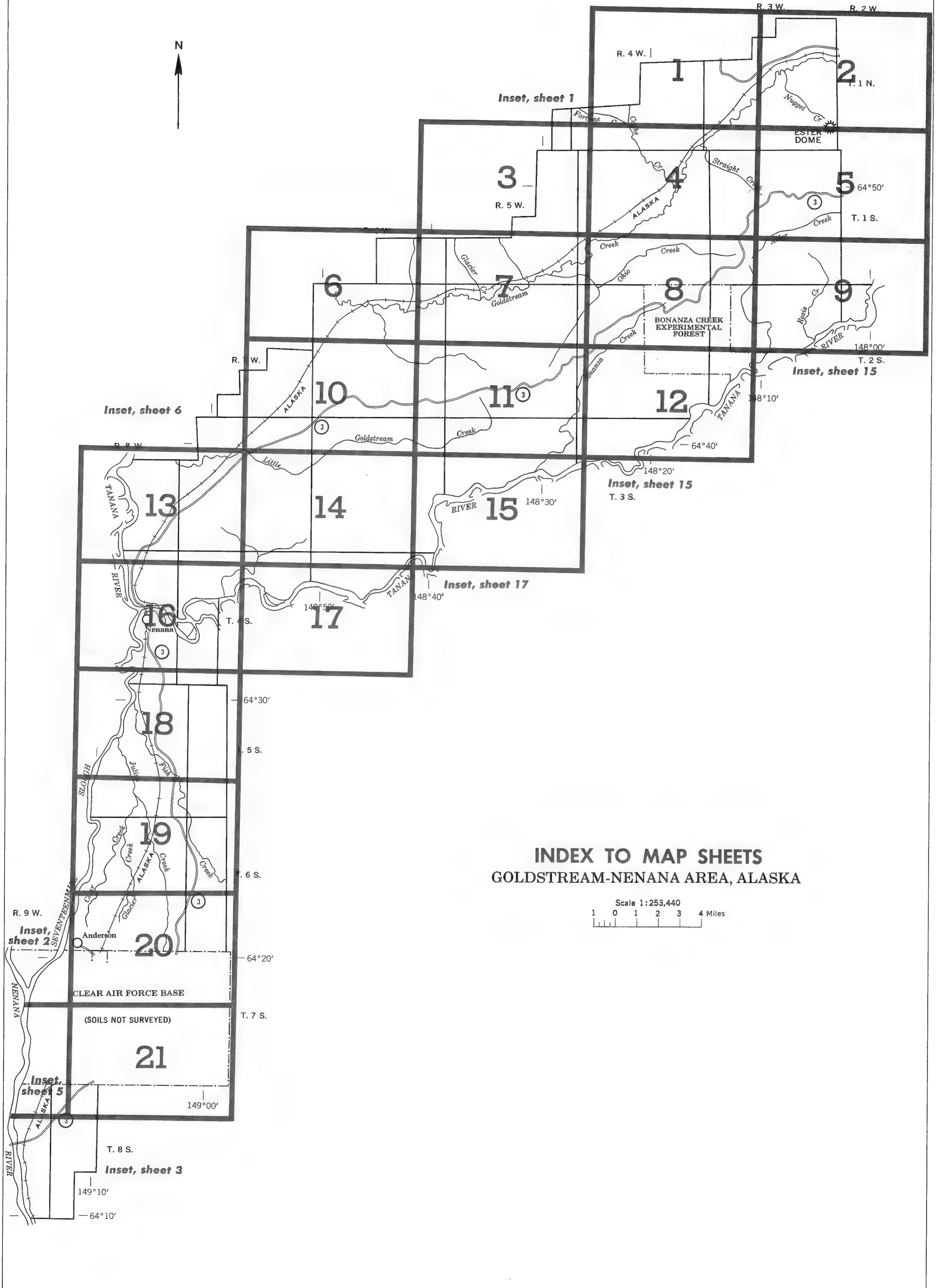
2 Minto-Goldstream association: Deep, nearly level to strongly sloping, moderately well drained silty soils, on foot slopes; and deep, nearly level to gently sloping, poorly drained silty soils with permafrost, on flood plains

3 Goldstream-Tanana association: Deep, nearly level to gently sloping, poorly drained and somewhat poorly drained silty soils with permafrost, on flood plains

4 Nenana-Tanana-Donnelly association: Very shallow to moderately deep, nearly level to steep, well-drained and excessively drained silty soils over gravel or sand, on outwash plains and moraines; and deep, nearly level, somewhat poorly drained silty soils with permafrost, on flood plains

Compiled 1976

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

GOLDSTREAM-NENANA AREA, ALASKA

Scale 1:253,440

1 0 1 2 3 4 Miles

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool (Davis Airstrip; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate (79)
- Federal (410)
- State (52)
- County, farm or ranch (378)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small (water; w)

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (GAS)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) (CANAL)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial (water; w)
- Intermittent (int; i)

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (CeA; FoB2)

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

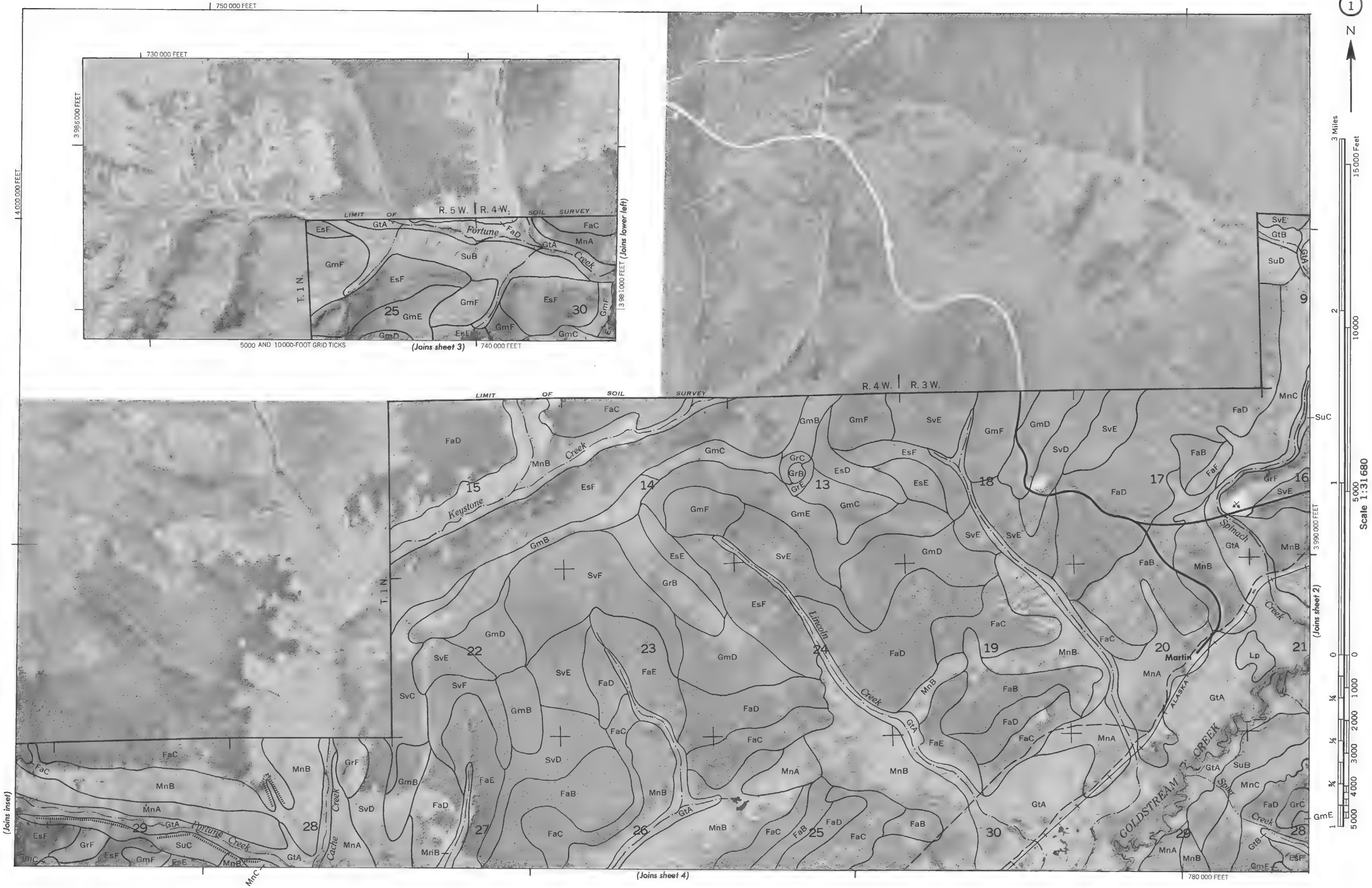
MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

SOIL LEGEND

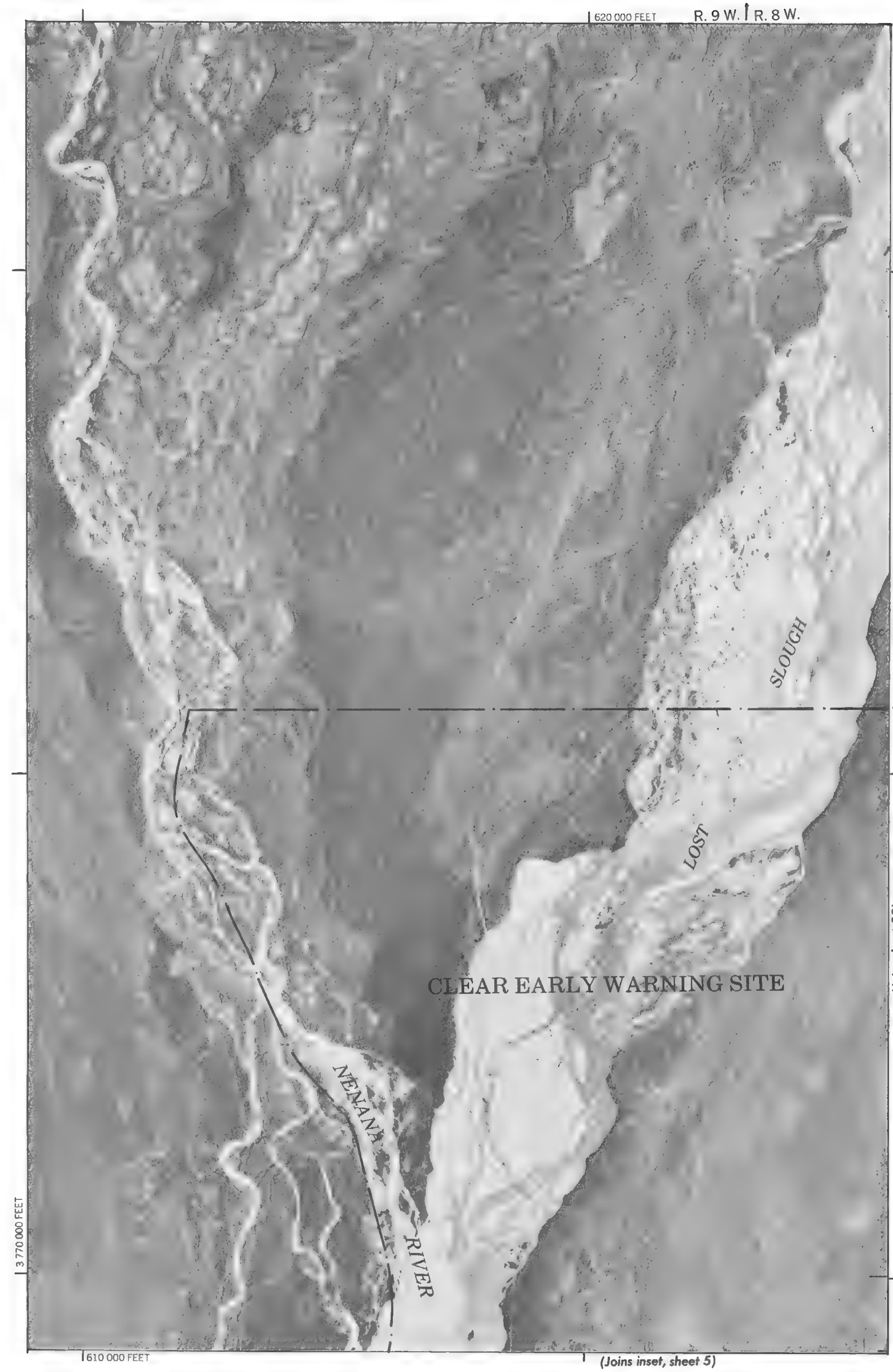
The first letter, always a capital, is the initial letter of the soil name. A second capital letter, A, B, C, D, E, or F, shows the slope. Symbols without a slope letter are for those of nearly level soils.

SYMBOL	NAME
Br	Bradway very fine sandy loam
DoA	Donnelly silt loam, nearly level
DoB	Donnelly silt loam, gently sloping
DoF	Donnelly silt loam, steep
EsD	Ester silt loam, strongly sloping
EsE	Ester silt loam, moderately steep
EsF	Ester silt loam, steep
FaA	Fairbanks silt loam, nearly level
FaB	Fairbanks silt loam, gently sloping
FaC	Fairbanks silt loam, moderately sloping
FaD	Fairbanks silt loam, strongly sloping
FaE	Fairbanks silt loam, moderately steep
FaF	Fairbanks silt loam, steep
GmB	Gilmore silt loam, gently sloping
GmC	Gilmore silt loam, moderately sloping
GmD	Gilmore silt loam, strongly sloping
GmE	Gilmore silt loam, moderately steep
GmF	Gilmore silt loam, steep
GrB	Gilmore silt loam, very shallow, gently sloping
GrC	Gilmore silt loam, very shallow, moderately sloping
GrE	Gilmore silt loam, very shallow, moderately steep
GrF	Gilmore silt loam, very shallow, steep
GtA	Goldstream silt loam, nearly level
GtB	Goldstream silt loam, gently sloping
GuA	Goodpaster silt loam
Lp	Lemeta peat
Me	Mine tailings
MnA	Minto silt loam, nearly level
MnB	Minto silt loam, gently sloping
MnC	Minto silt loam, moderately sloping
MnD	Minto silt loam, strongly sloping
NaA	Nenana silt loam, nearly level
NaB	Nenana silt loam, gently sloping
NeA	Nenana silt loam, sandy substratum, nearly level
NeB	Nenana silt loam, sandy substratum, gently sloping
Sc	Salchaket very fine sandy loam
SuA	Saulich silt loam, nearly level
SuB	Saulich silt loam, gently sloping
SuC	Saulich silt loam, moderately sloping
SuD	Saulich silt loam, strongly sloping
SuE	Saulich silt loam, moderately steep
SuF	Saulich silt loam, steep
SvB	Steese silt loam, gently sloping
SvC	Steese silt loam, moderately sloping
SvD	Steese silt loam, strongly sloping
SvE	Steese silt loam, moderately steep
SvF	Steese silt loam, steep
Ta	Tanana silt loam
Vk	Volkmar silt loam



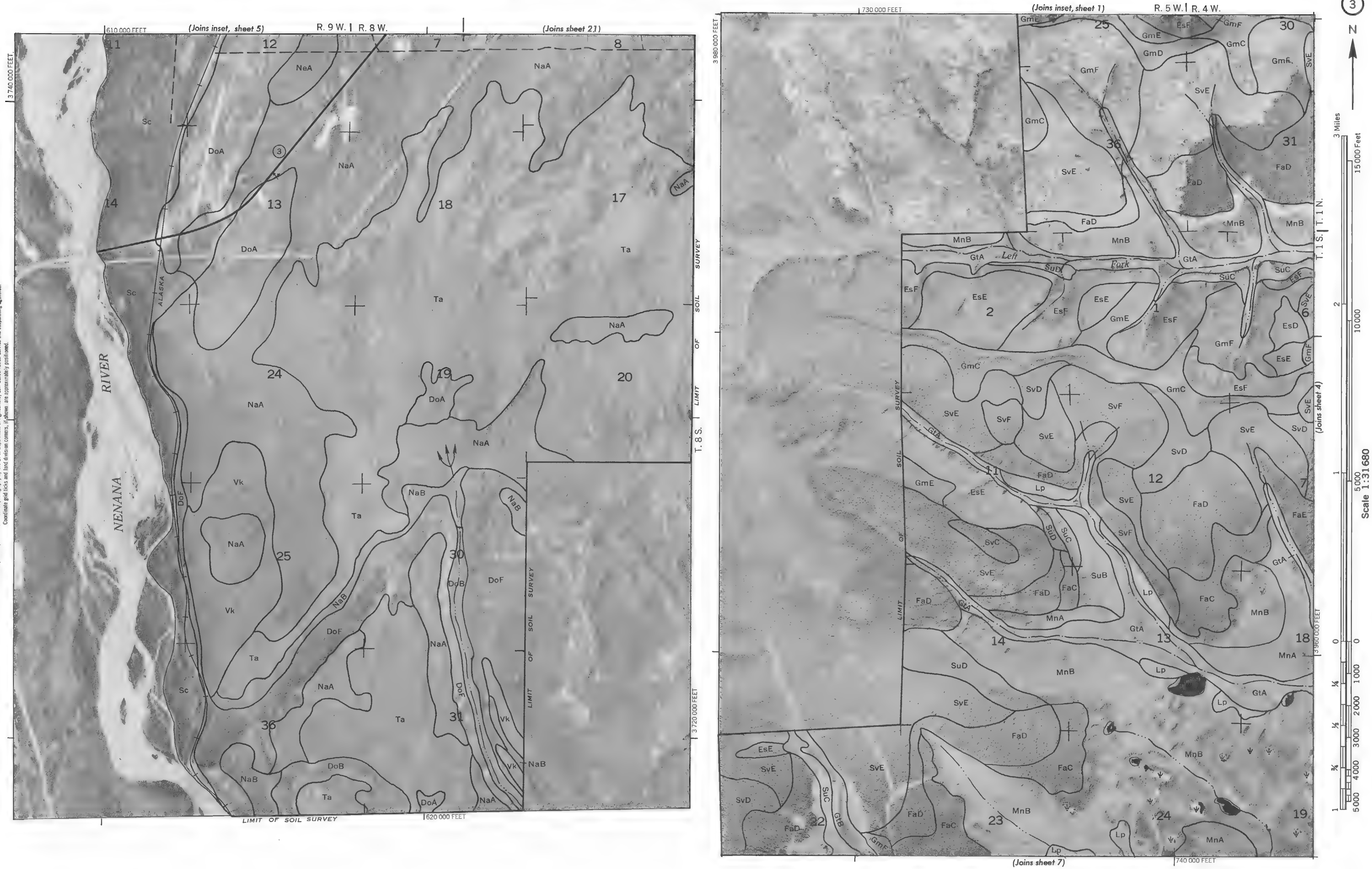
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

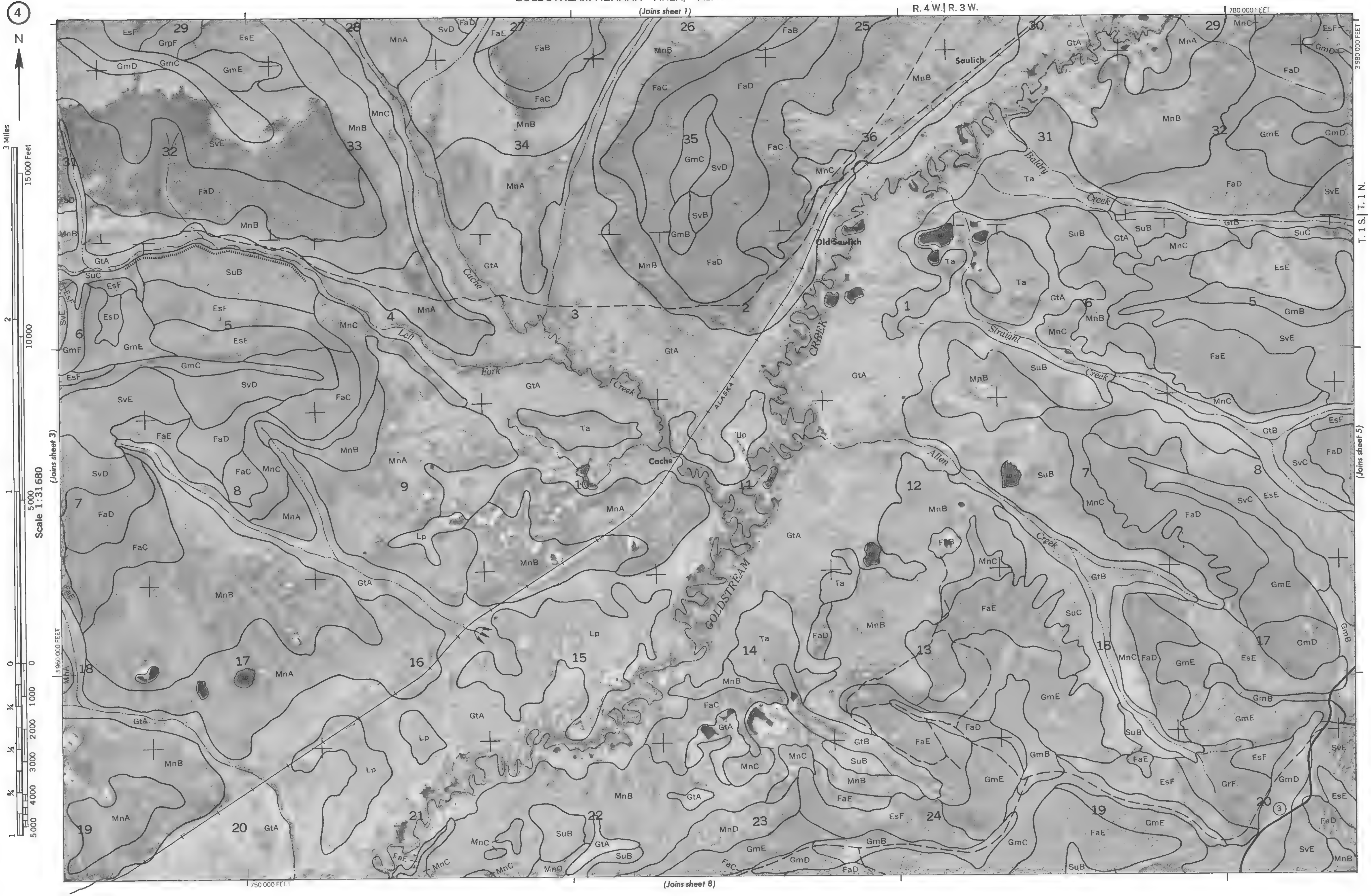
GOLDSTREAM-NENANA AREA, ALASKA NO. 1



GOLDSTREAM-NENANA AREA, ALASKA NO. 2

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

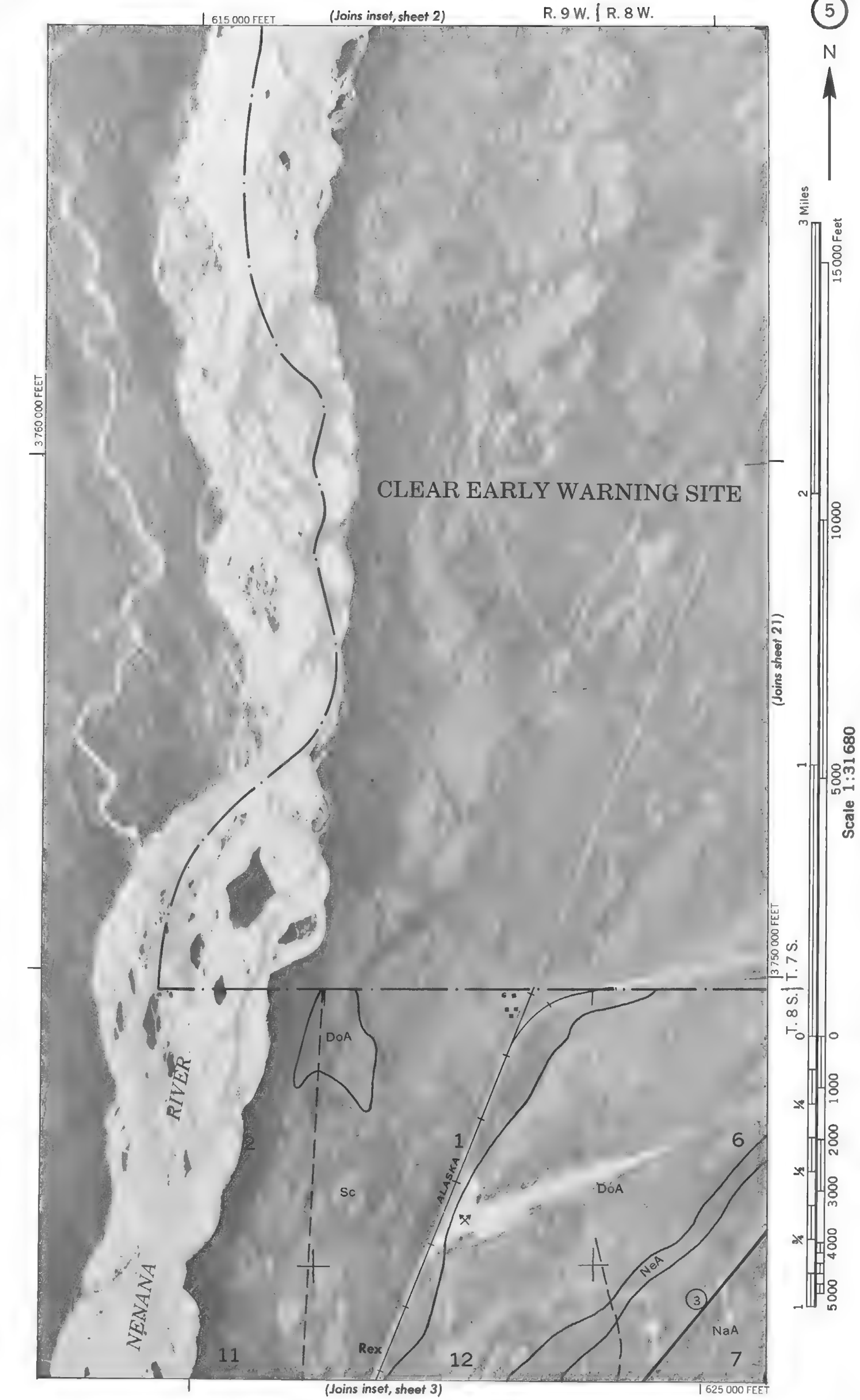

3
N
(Joins inset, sheet 5)
R. 9 W. R. 8 W.
(Joins sheet 21)
(Joins inset, sheet 1)
R. 5 W. R. 4 W.
(Joins sheet 4)
(Joins sheet 7)
NENANA
RIVER
ALASKA
Left Fork
LIMIT OF SOIL SURVEY
T. 8 S.
T. 1 N.
T. 1 S.
610 000 FEET
620 000 FEET
730 000 FEET
740 000 FEET
3 740 000 FEET
3 720 000 FEET
3 980 000 FEET
3 960 000 FEET
Scale 1:31680
3 Miles
15 000 Feet
GOLDSTREAM-NENANA AREA, ALASKA NO. 3



GOLDSTREAM-NENANA AREA, ALASKA NO. 4

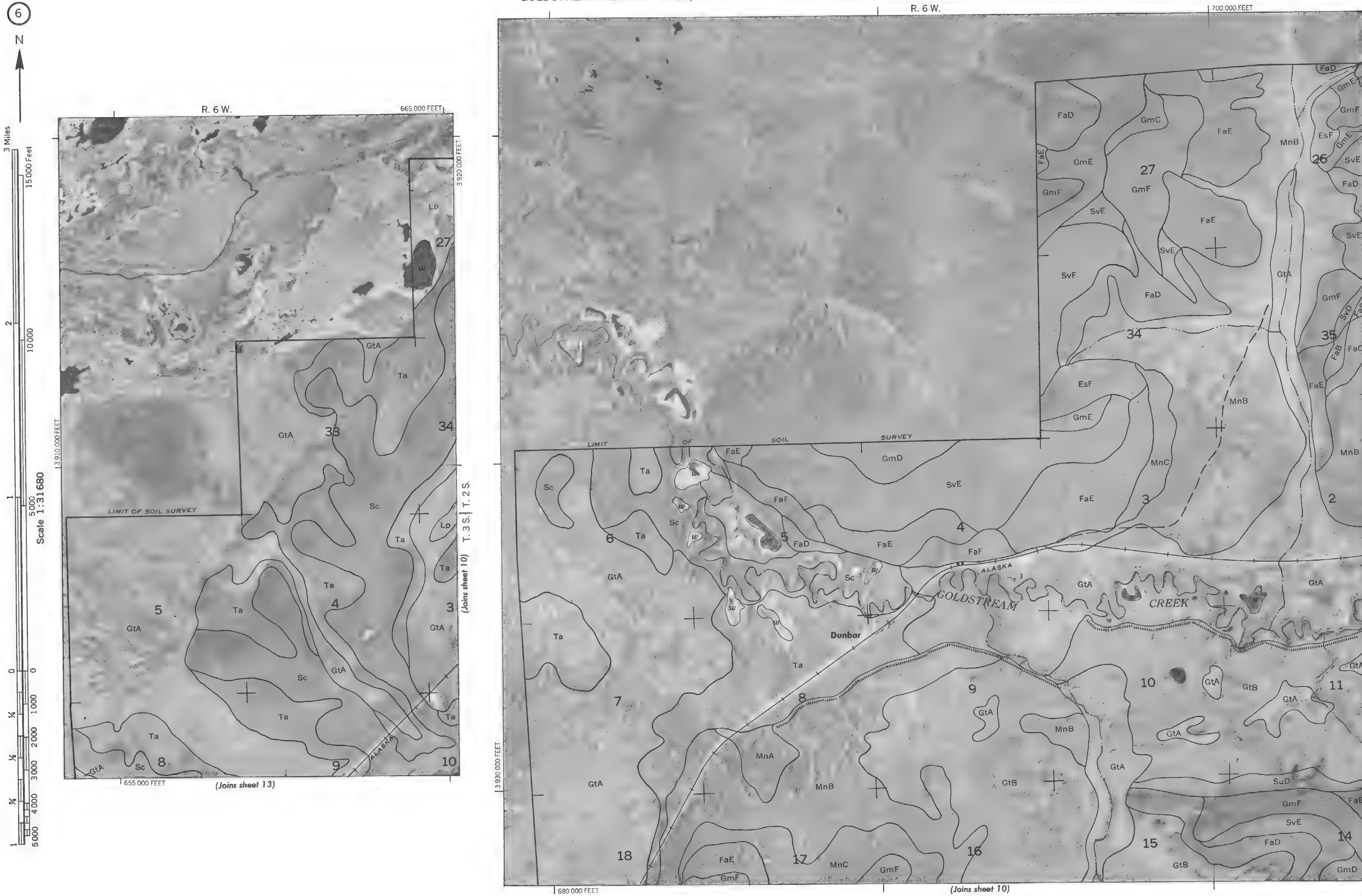
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5



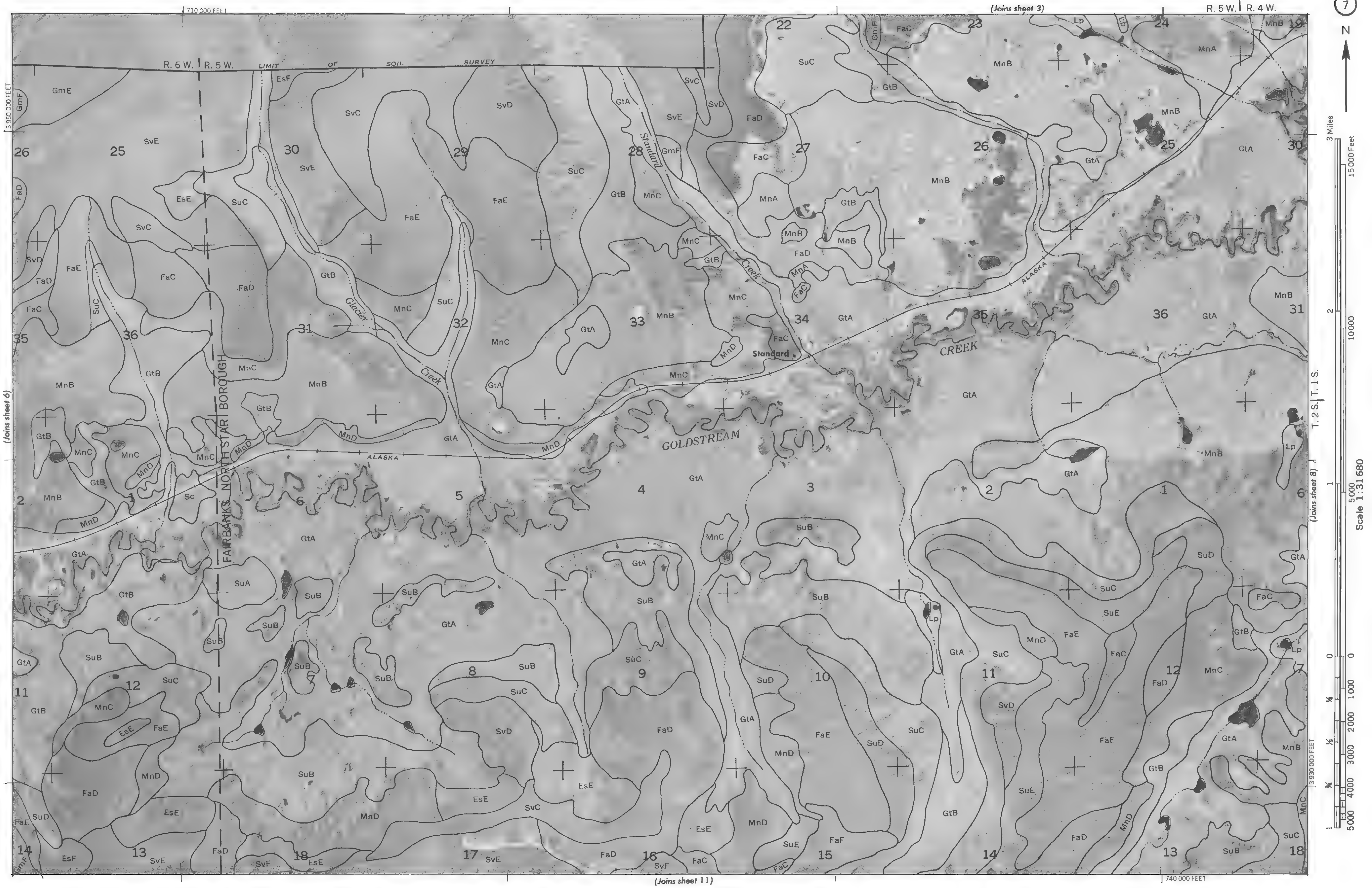
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GOLDSTREAM-NENANA AREA, ALASKA NO. 5



GOLDSTREAM-NENANA AREA, ALASKA NO. 6

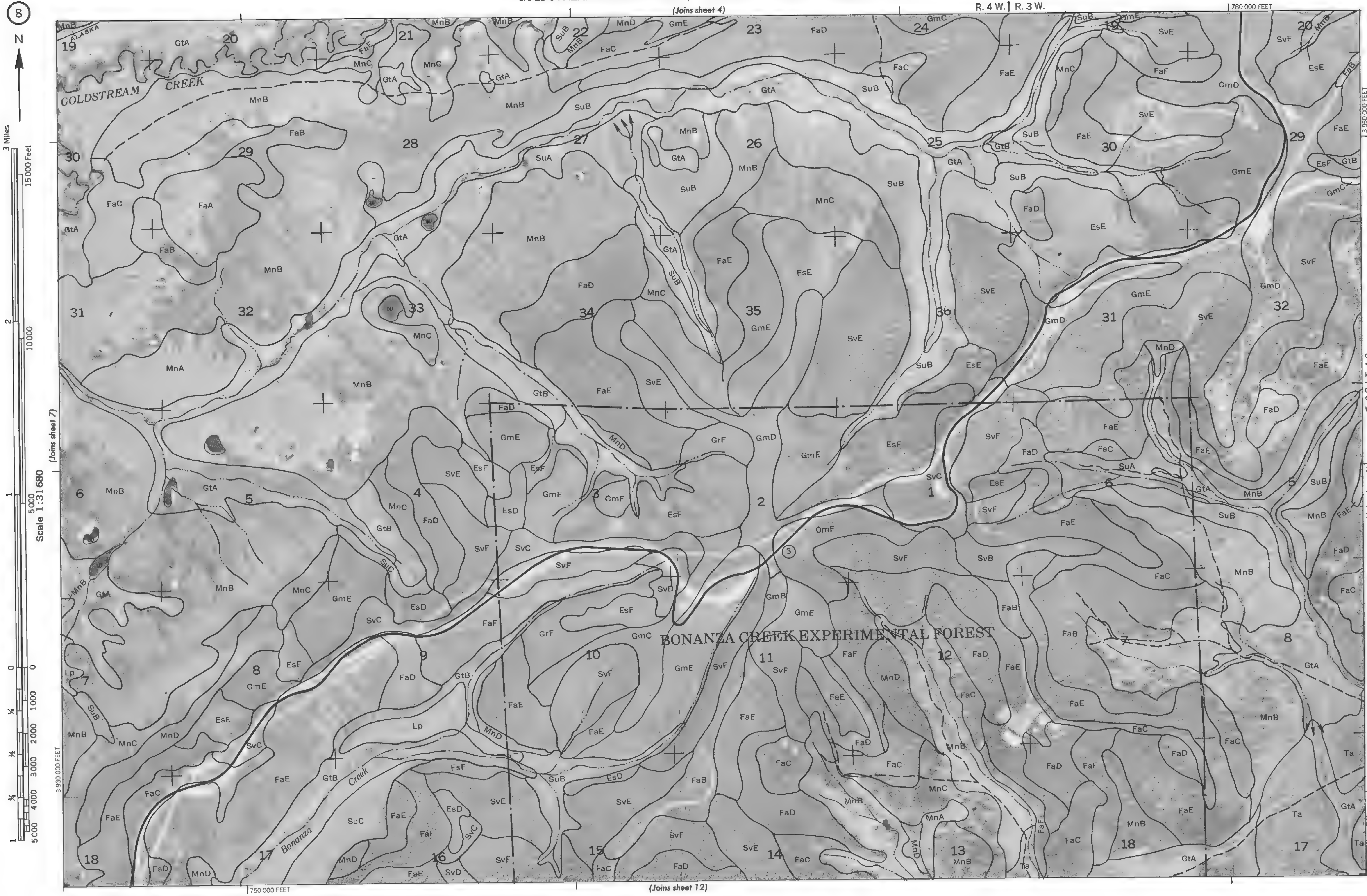
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

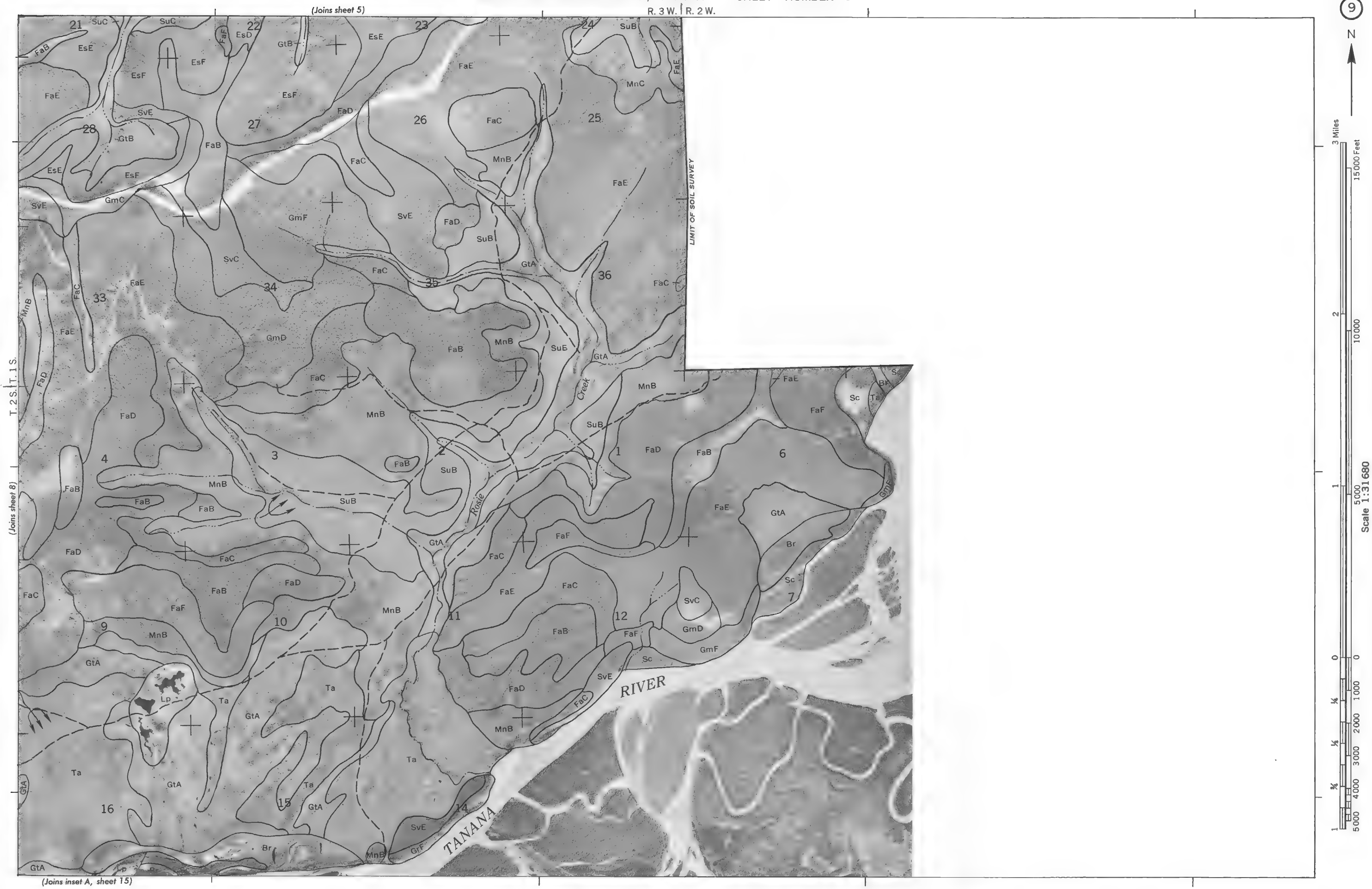
GOLDSTREAM-NENANA AREA, ALASKA NO. 7

GOLDSTREAM-NENANA AREA, ALASKA — SHEET NUMBER 8



GOLDSTREAM-NENANA AREA, ALASKA NO. 8

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

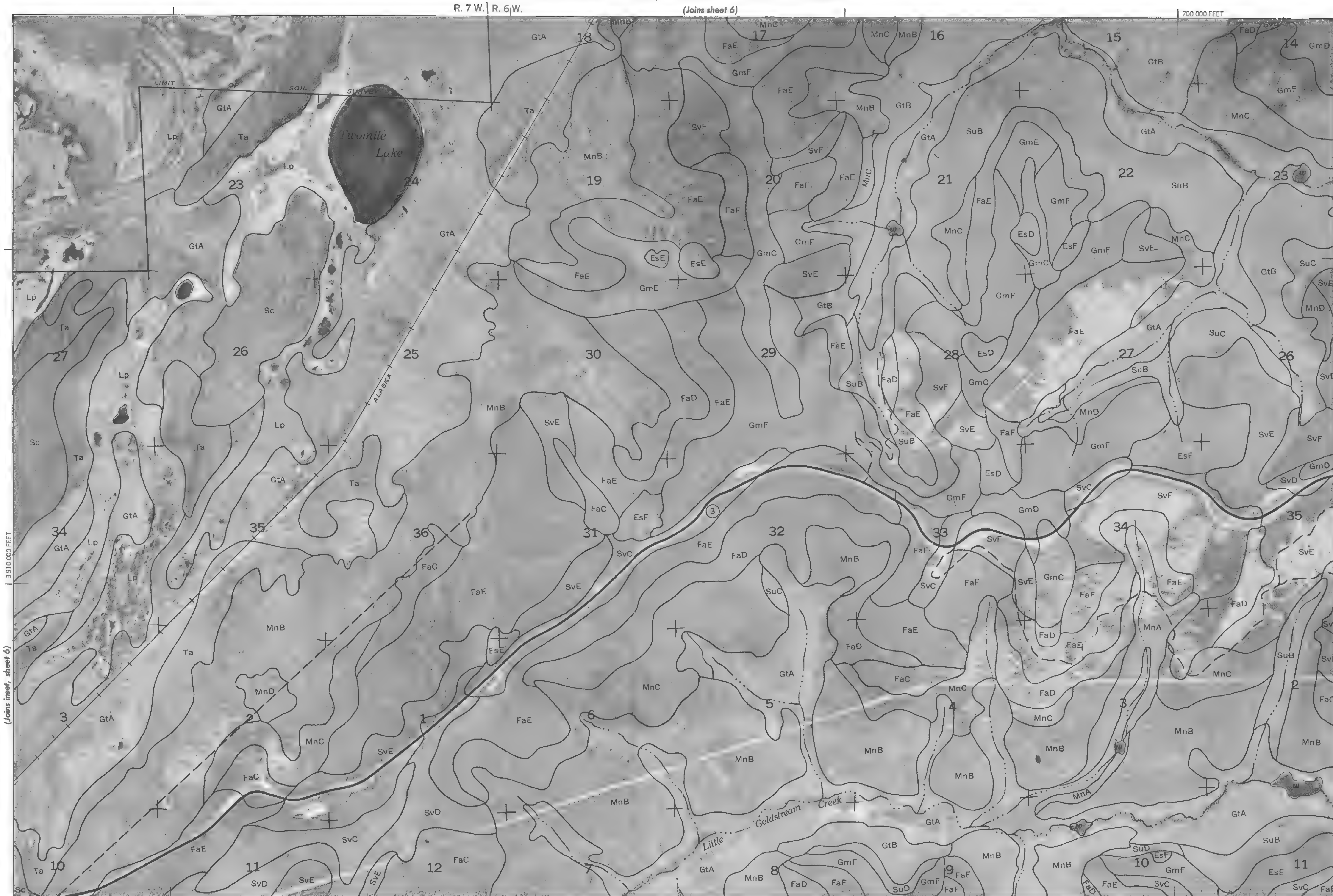


This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GOLDSTREAM-NENANA AREA, ALASKA NO. 9

10

N

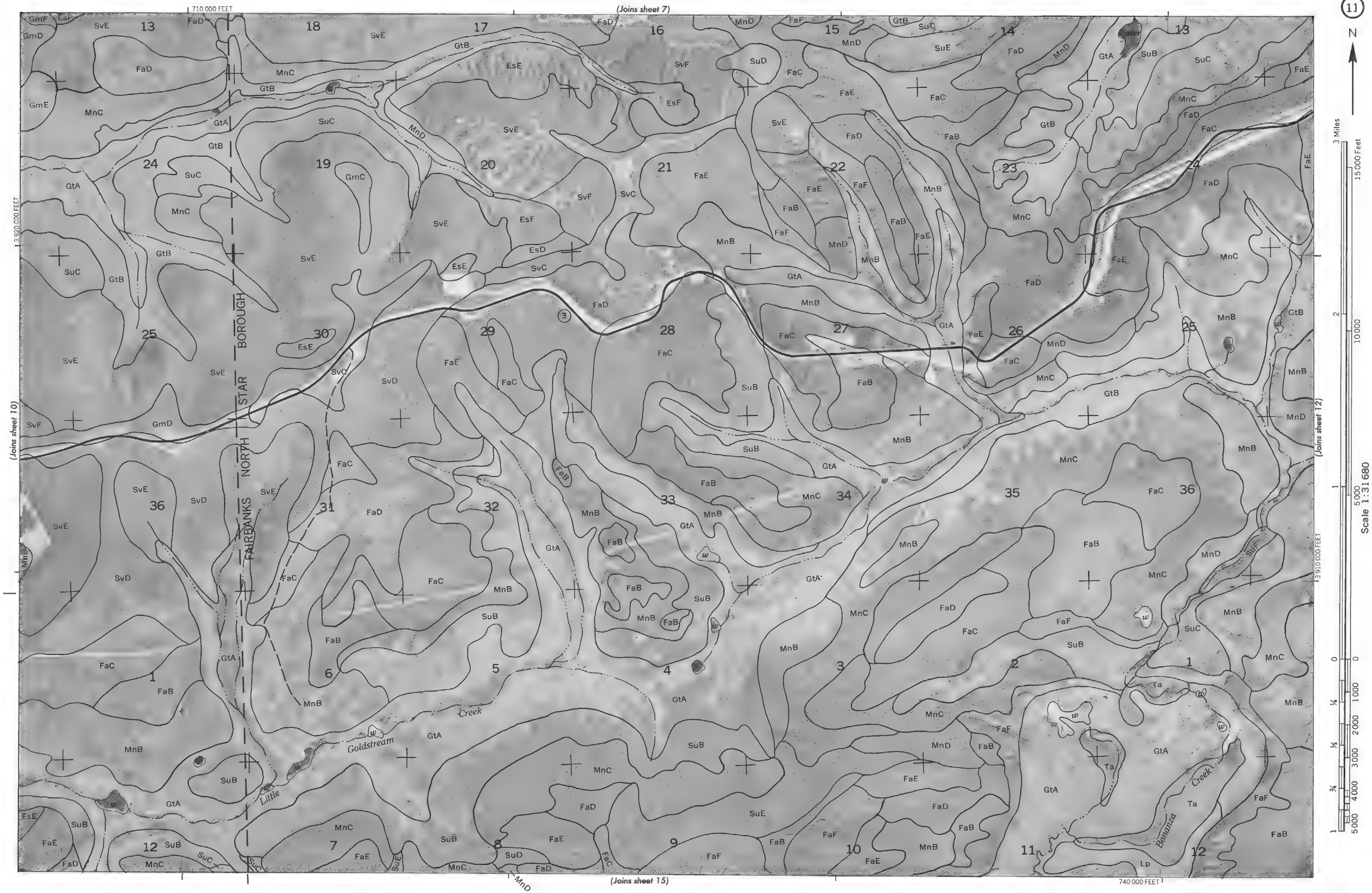


Scale 1:31 680

3 Miles, 2, 1, 1/4... 0; 15 000 Feet, 10 000, 5 000, 0, 1000, 2000, 3000, 4000, 5000

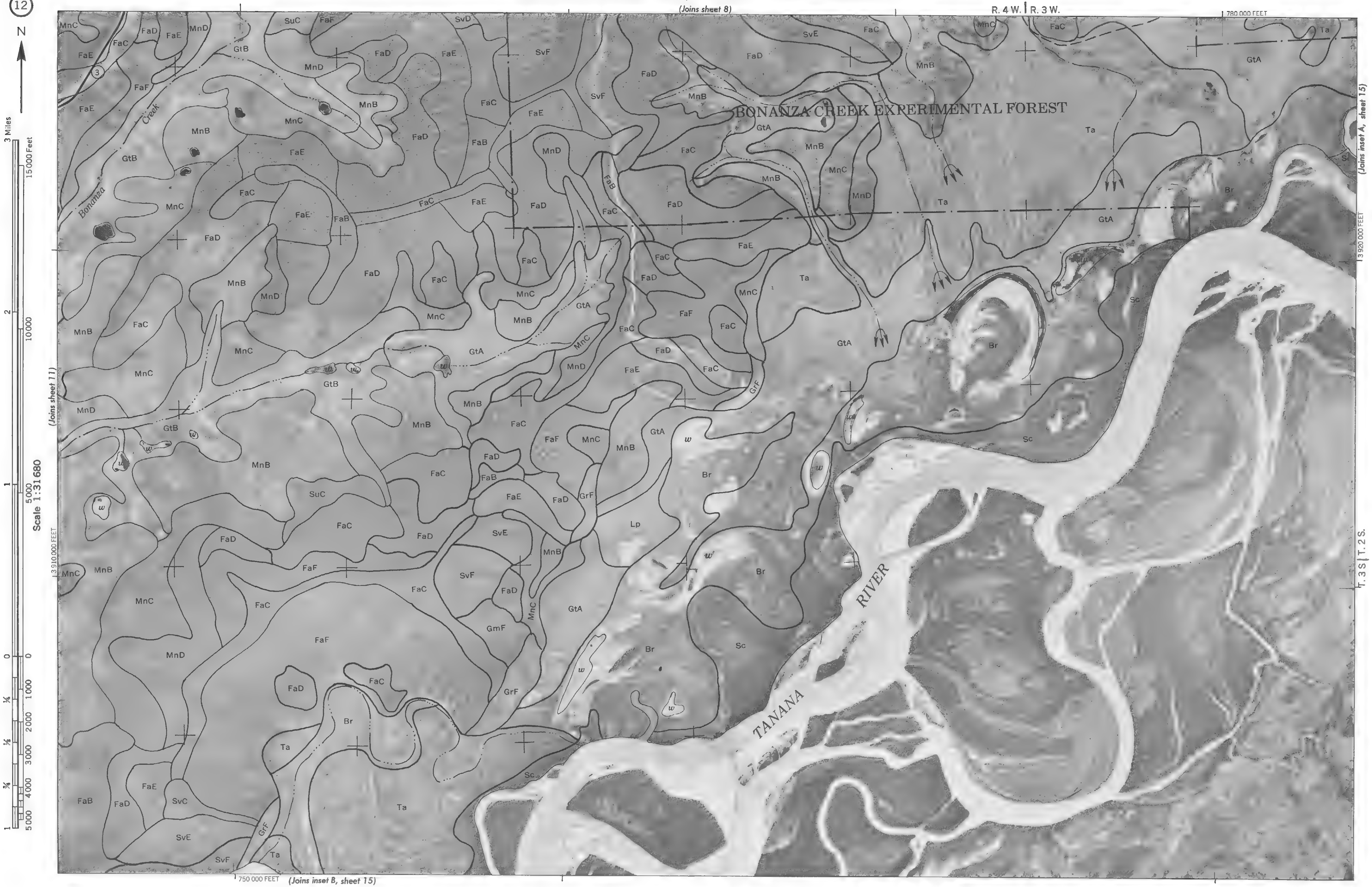
GOLDSTREAM-NENANA AREA, ALASKA NO. 10

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

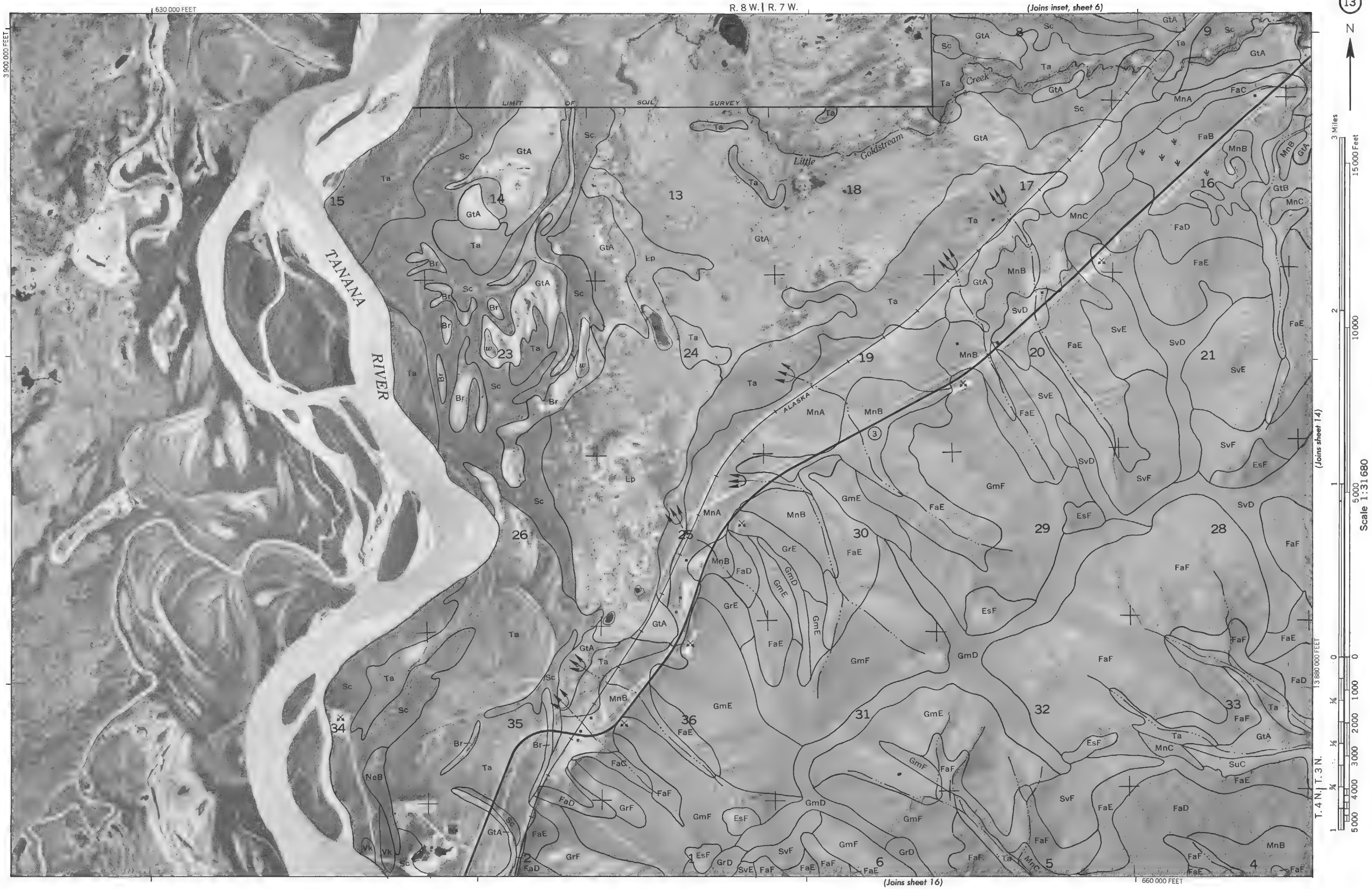
GOLDSTREAM-NENANA AREA, ALASKA NO. 11



GOLDSTREAM-NENANA AREA, ALASKA NO. 12

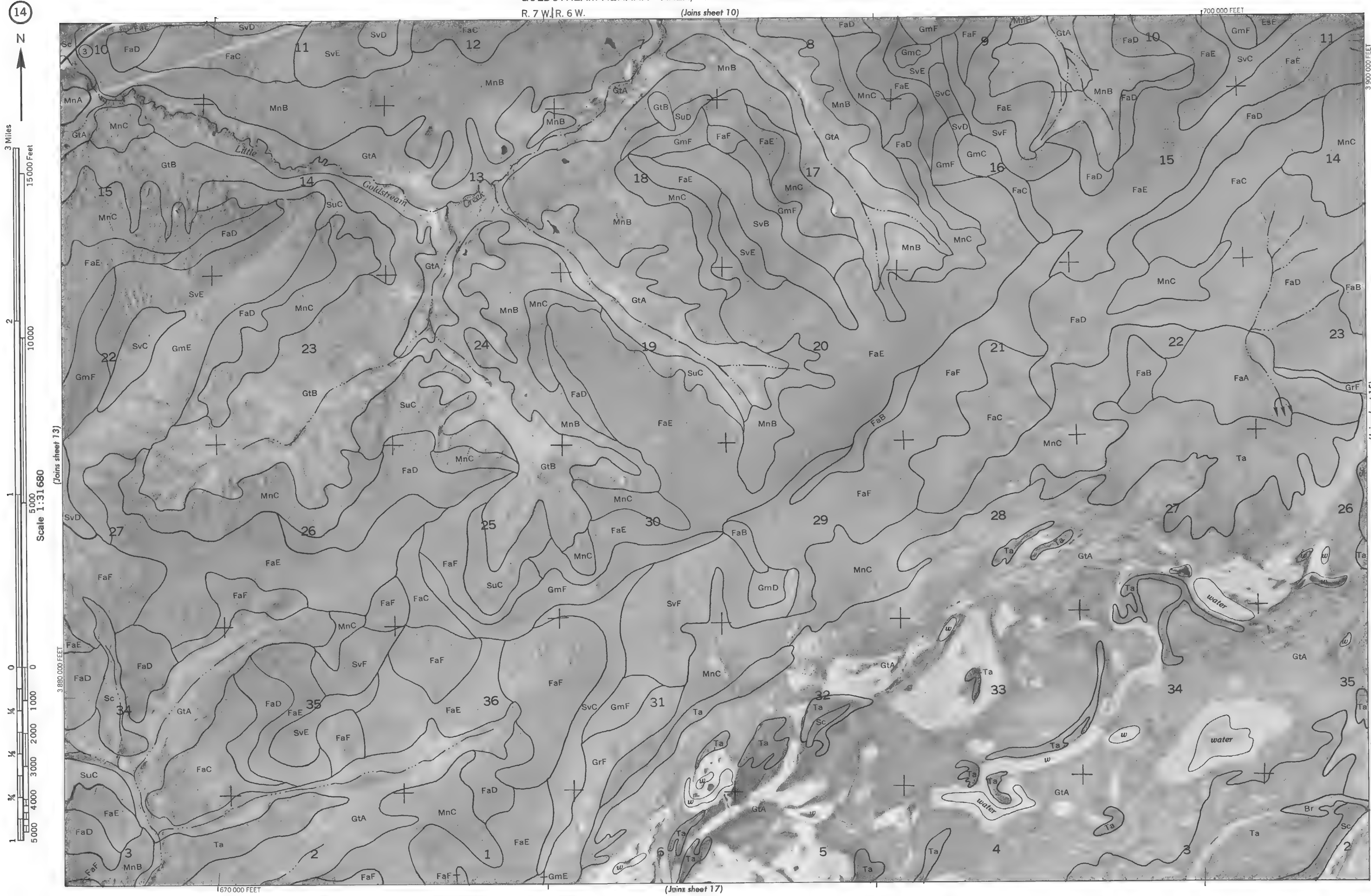
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GOLDSTREAM-NENANA AREA, ALASKA — SHEET NUMBER 13



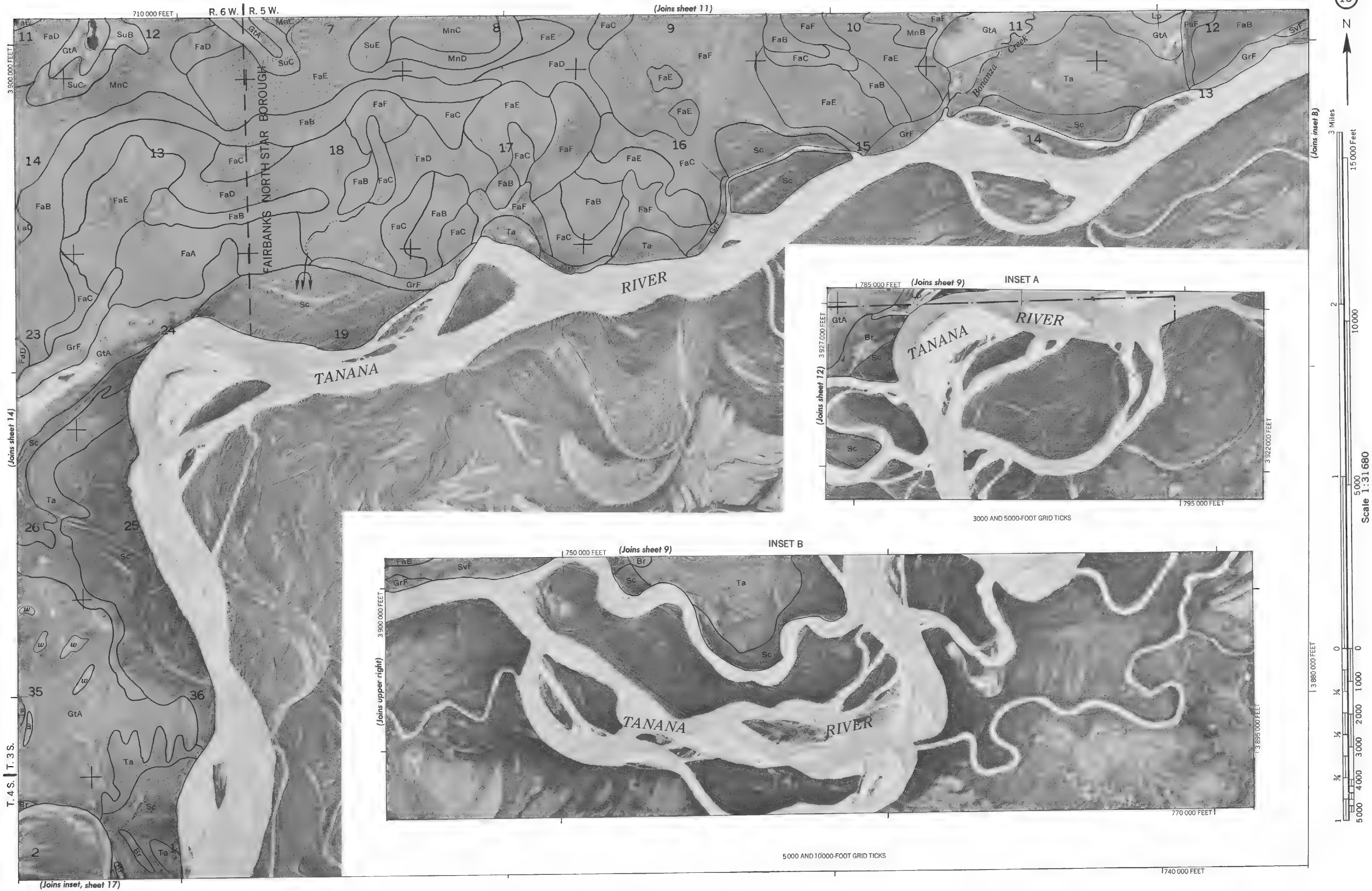
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GOLDSTREAM-NENANA AREA, ALASKA, NO. 13



GOLDSTREAM-NENANA AREA, ALASKA NO. 14

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

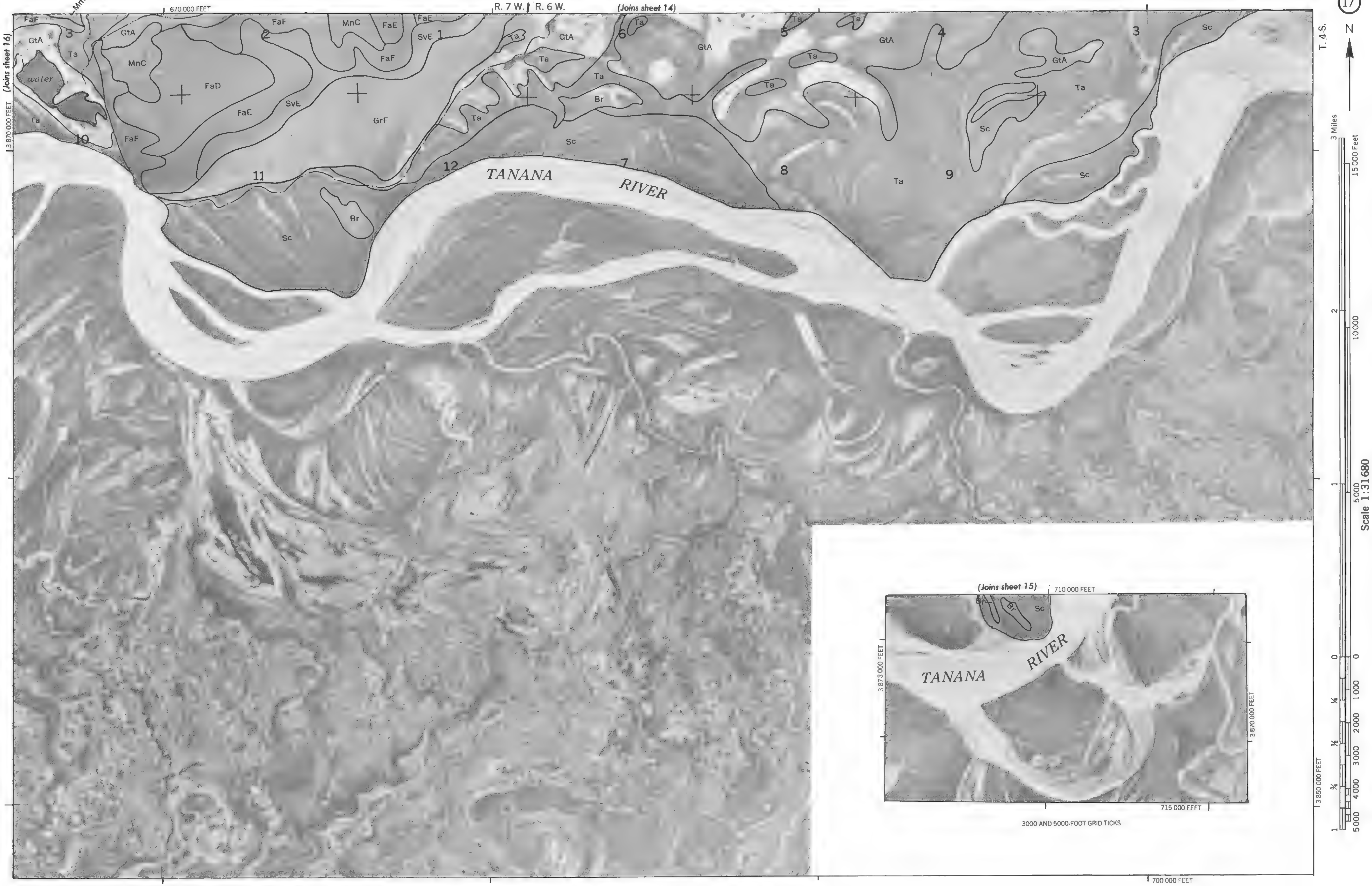


This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GOLDSTREAM-NENANA AREA, ALASKA NO. 15

GOLDSTREAM-NENANA AREA, ALASKA NO. 16

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

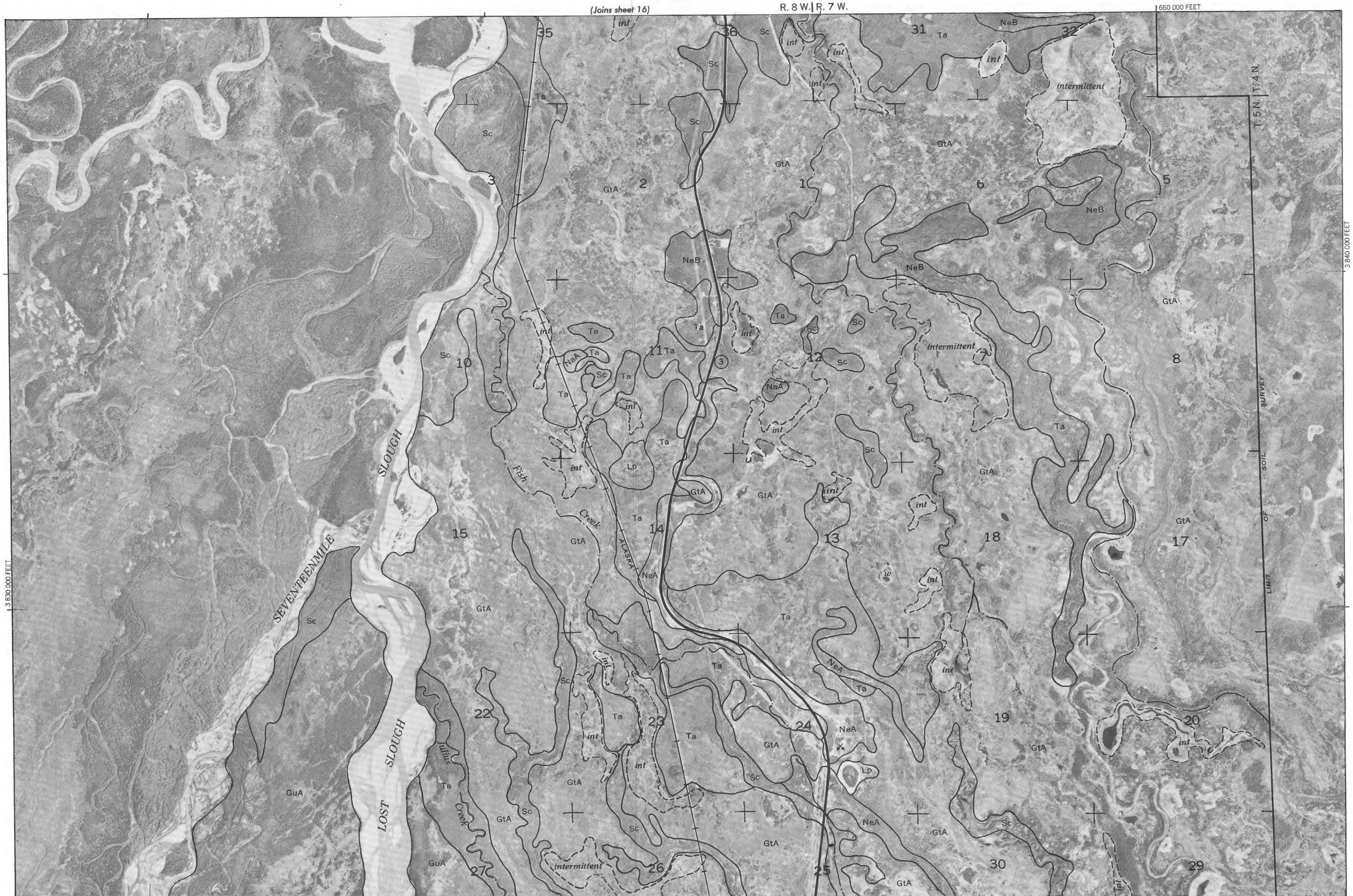
GOLDSTREAM-NENANA AREA, ALASKA NO. 17

GOLDSTREAM-NENANA AREA, ALASKA — SHEET NUMBER 18

(18)

(Joins sheet 16)

R. 8 W. | R. 7 W.

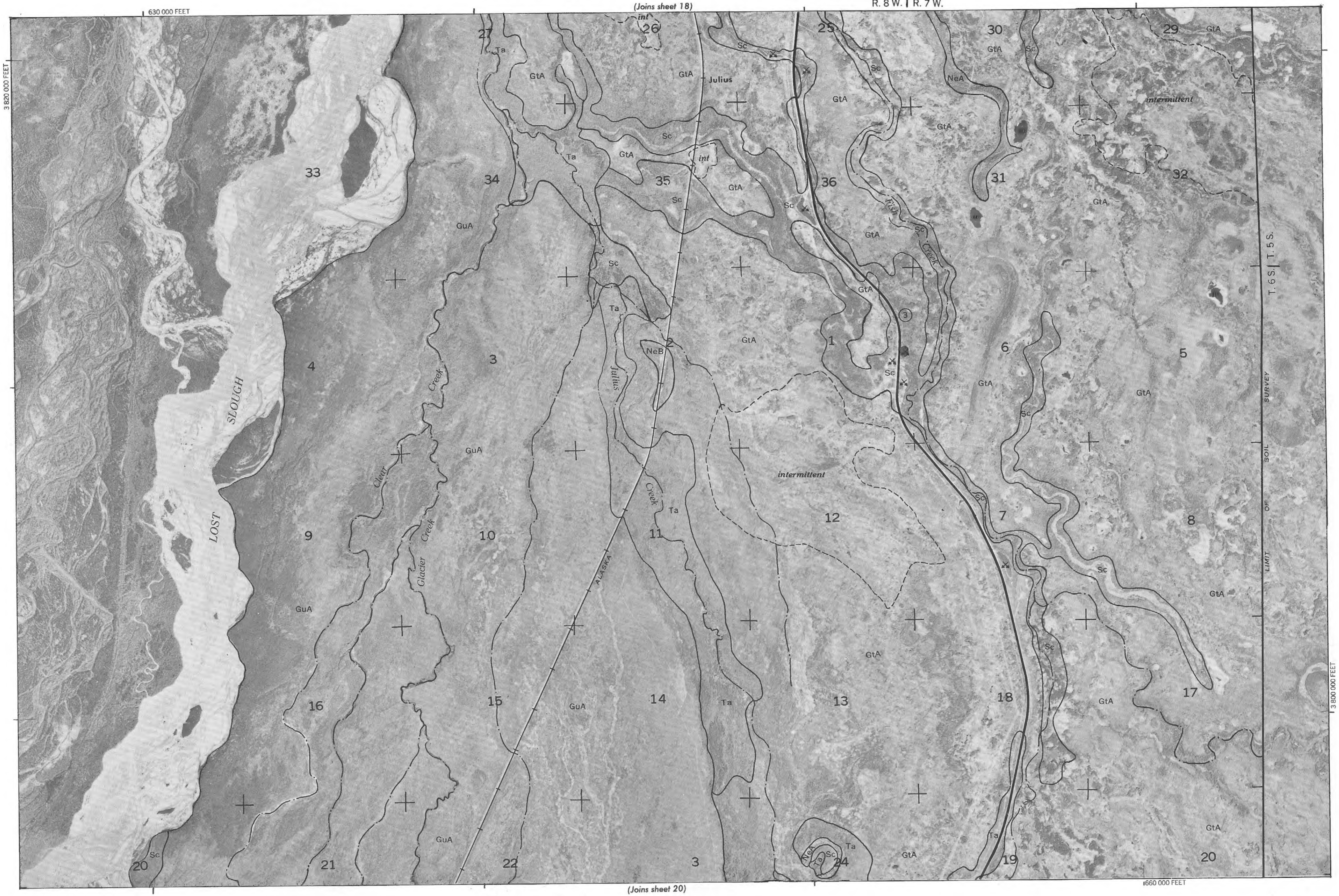


(Joins sheet 19)

GOLDSTREAM-NENANA AREA, ALASKA NO. 18

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

19

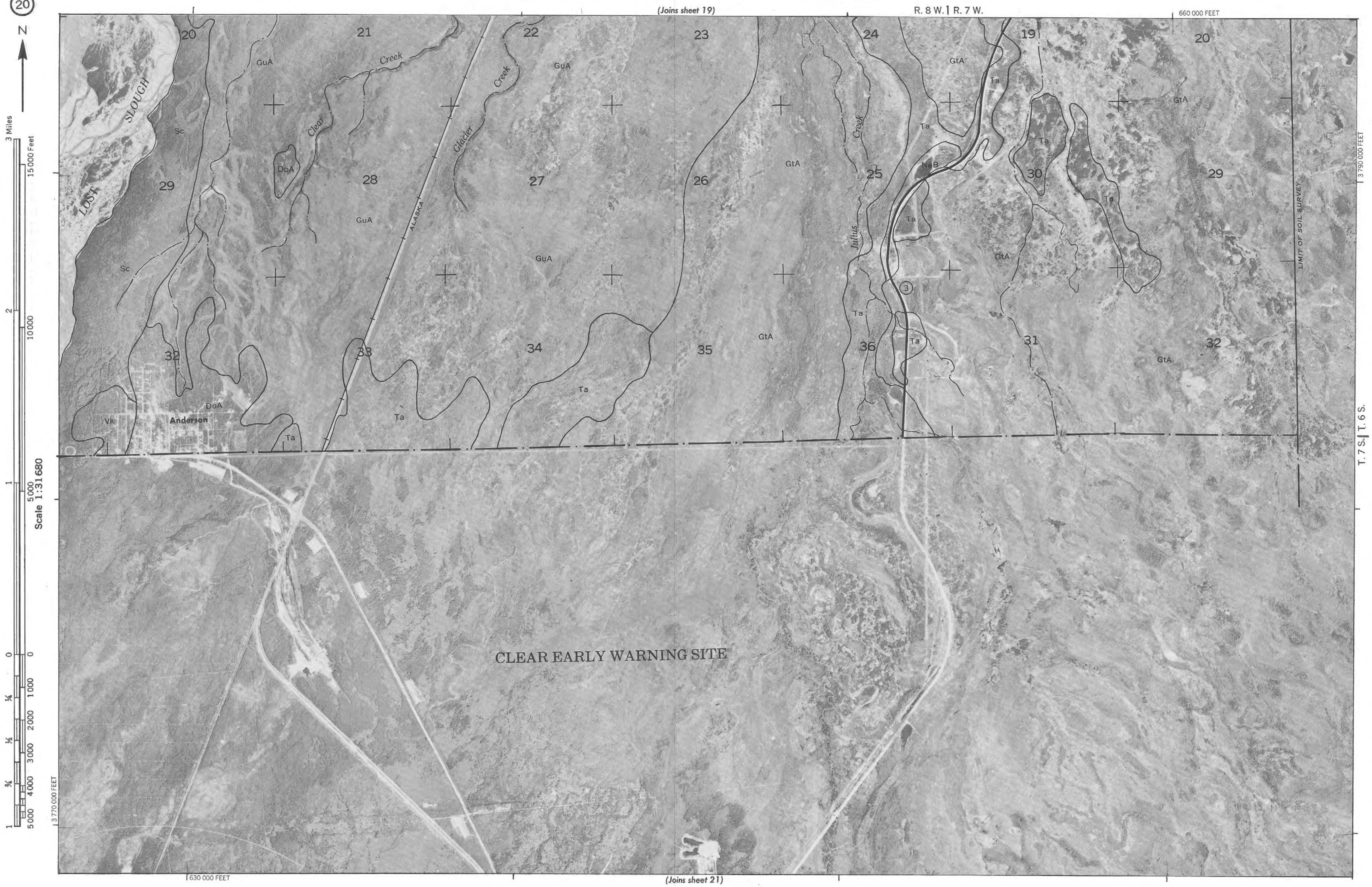


N

Scale 1:31 680

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

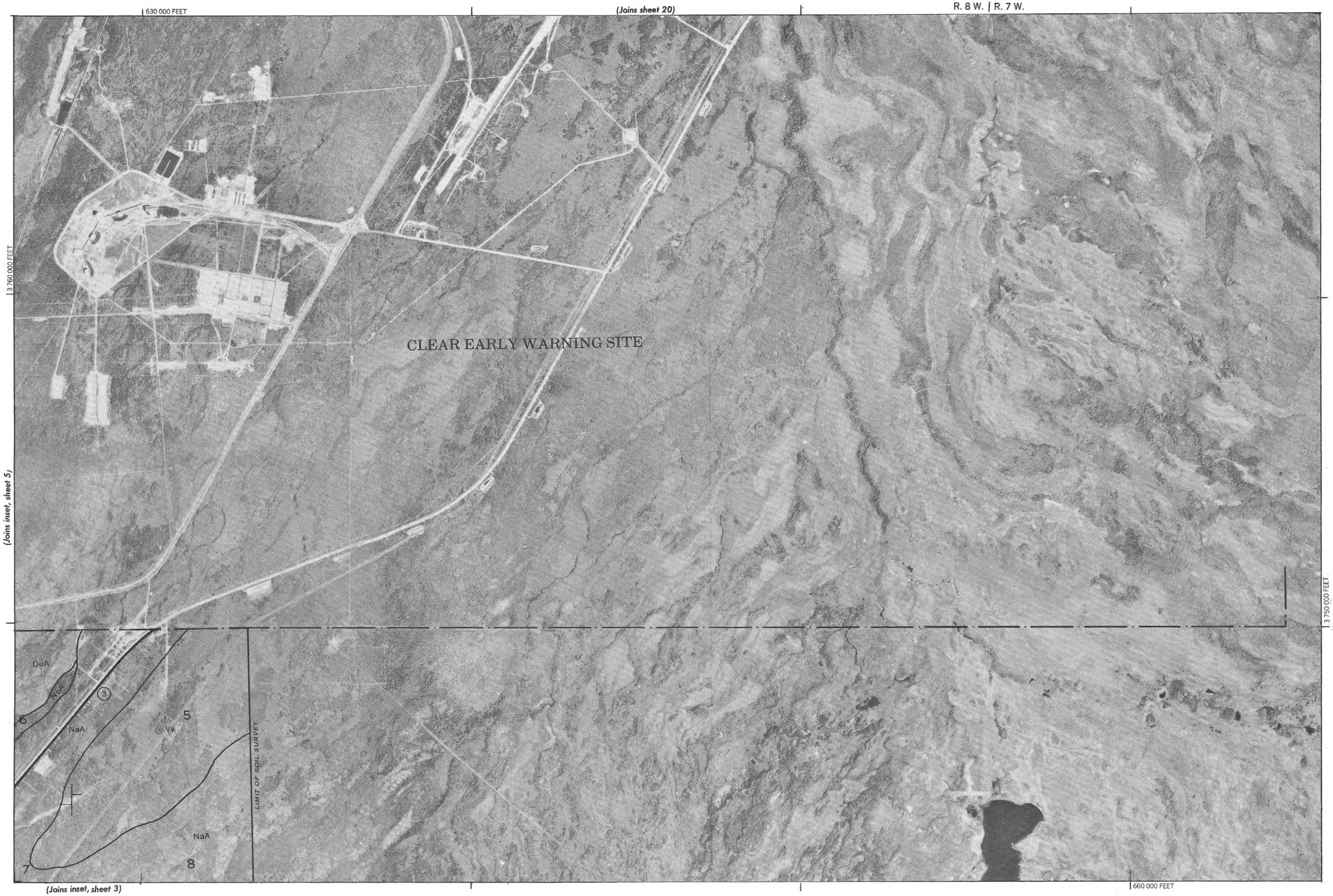
GOLDSTREAM-NENANA AREA, ALASKA NO. 19



GOLDSTREAM-NENANA AREA, ALASKA NO. 20

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(21)



N

3 Miles
2
1
¾
½
¼
0
15 000 Feet
10 000
5 000
5000
4000
3000
2000
1000
0
Scale 1:31 680

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.